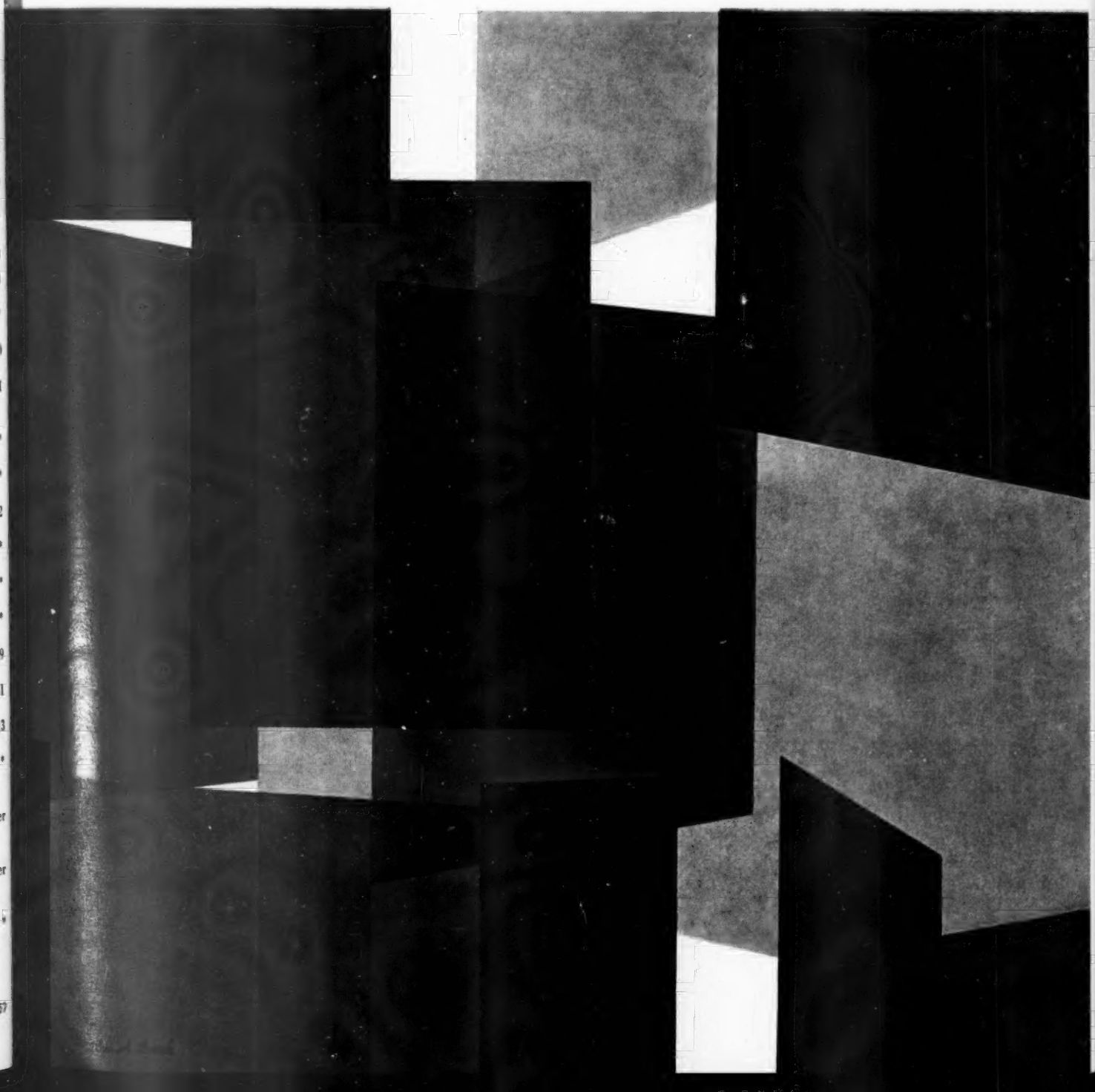
AIR ENGINEERING

AUGUST, 1959

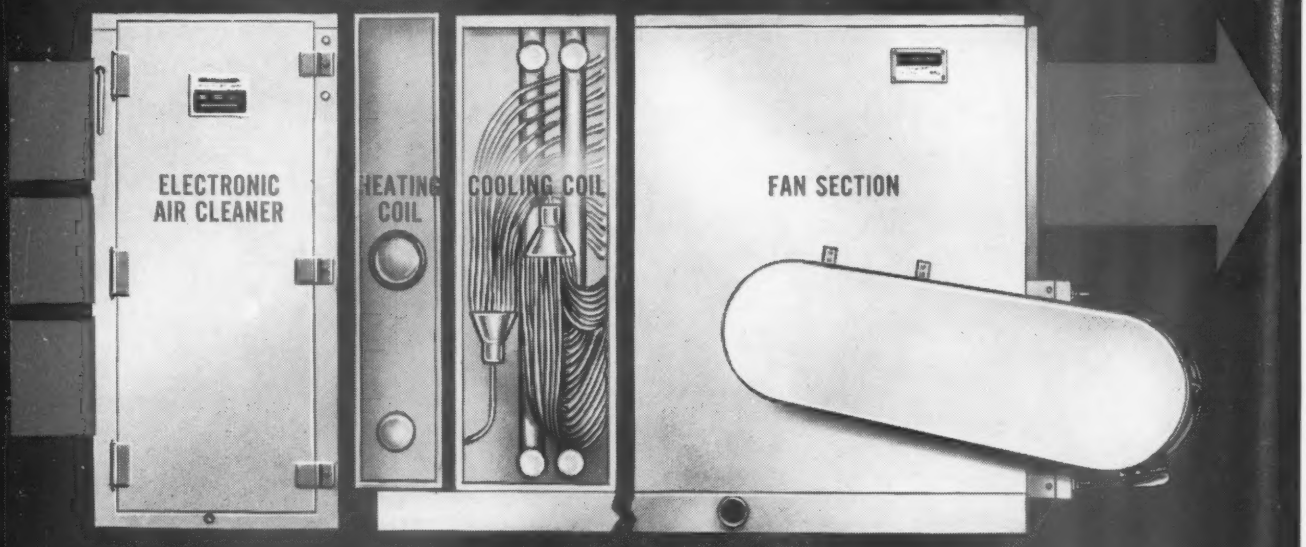
AIR POLLUTION CONTROL • AIR MOVING • AIR CONDITIONING

- *Air Engineering for Factories . . . A Primer*
- *If Beryllium Comes to Your Plant . . . Dust Control Methods*
- *7 Ways to Test Industrial Ventilation Systems*
- *Engineer's Guide to Industrial Contaminants*



when you

condition air and distribute air...



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Electronic Air Cleaner Sections for "In-Line" Assembly only 25½" in direction of air flow—with manual or automatic washing. Manufacturing plants at Hyde Park, Mass. • LaSalle, Ill. • Berkeley, Calif.

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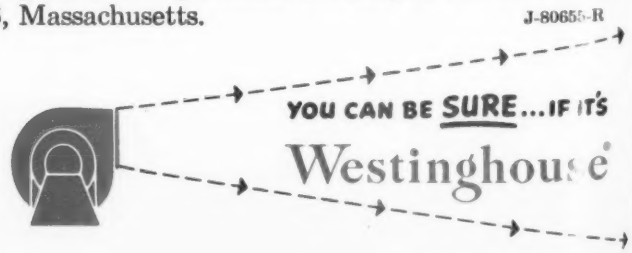

AIR ENGINEERING

VOL. 1, No. 5

AUGUST, 1959

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DEDICATED TO THE SCIENCE OF AIR POLLUTION CONTROL
AIR MOVING • AIR CONDITIONING

LIST. 21

FEATURES

Engineer's Guide to Industrial Contaminants 17

Primer on Factory Ventilation 22

How to Stop Smog 26

Techniques of Laboratory Ventilation 27

Fans for High Temperatures, Part II 32

Meteorology . . . a Modern Management Tool, Part II 34

If Beryllium Comes to Your Plant (Dust Collection Methods) 40

Low Cost Hot Gas Cleaning, Part II 43

How to Test Industrial Ventilation Systems 46

DEPARTMENTS

Letters 2

Newsletter 3

Editorial 5

New Products 7

News of the Industry 8

*Air Pollution Complaint$** 11

Meetings 11

New Literature 16

New Appointments 21

Communications Center 37

Advertiser's Index 51

Classified Ads 51

Professional Services 51

***Air Pollution Complaint$** is a new department. It spotlights cities and individual factories in those cities where air pollution problems are active . . . and a ripe market for control equipment exists.

AIR ENGINEERING is published monthly by Business News Publishing Company, at 450 West Fort Street, Detroit 26, Michigan. Subscription prices: United States, Canada: $3.00—1 year; $4.50—2 years; $6.00—3 years. Foreign: $5.00—1 year; $8.50—2 years; $12.00—3 years. Single copies 50 cents. Accepted as controlled circulation publication at U. S. Post Office, Detroit, Michigan. First issue April, 1959. • CHANGE OF ADDRESS. Notify AIR ENGINEERING and your local post-office of both your old and new addresses including postal zone numbers by 12th of preceding month. • CONTENTS COPYRIGHT 1959 by Business News Publishing Company. Reproduction of material may not be made without written permission of the publisher.

A day to remember. The sweep of sky and water . . . the fresh, clean feel of sea air. Air as clean and pure in a home? Certainly. Install Dust-magnet filters. Dust-magnets are electrostatic, *permanent* . . . rinse clean in a jiffy for immediate replacement in air conditioners and furnaces. Non-clogging, no oil coatings. As you live and *breathe* . . . install Dust-magnets!

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Letters

On Properly Engineered Work

Editor:

If, as assumed, your staff has done an accurate job of reporting the "pulse" of the architect-consulting engineer-contractor panel discussion at the recent Mechanical Contractors Association meeting (page 9, June issue), it is apparent that there is a long road ahead until there is full appreciation of "properly engineered work." For a contractor to suggest "not using consulting engineering drawings in actual field construction" means either "worthless engineering" or a "contractor" not worthy of the name. In any event, "he who pays the total bill for the project" comes out the loser.

Lester L. Bosch
Bosch & LaTour
Engineers-Consultants
2186 Victory Parkway
Cincinnati 6, Ohio

No Caps on Exhaust Stacks

Editor:

I have read some of the articles in this magazine and, of course, am interested because they are definitely in the field which we are in.

In going over the magazine my attention was attracted to photograph on bottom of Page 47. I can see that Zippo Manufacturing Company, Bradford, Pennsylvania, bought several nice chemical exhaust systems; but I can think of so many reasons why the exhaust stacks should not be capped that I shall list them below:

1—Probably the capping of fan stacks started in the days of gravity stacks when sheet metal men made livings by capping every stack in sight.

2—Zippo Manufacturing have purchased two systems as photograph indicates and apparently expended quite a bit of money for them. Then, on the top of the stacks they put caps which definitely turn the gases down on the roof. At certain times when wind velocity, pressure, temperature and humidity is just right, this means that the roof, and especially if it has a parapet wall, will be filled with acid fumes. They will move horizontally and re-enter the building through fresh air intakes etc.

3.—The best way to diffuse these

(Please turn to page 6)

New Radioactivity Filter

For filtering radioactive iodine from the air . . . a new silver-plated copper filter – like a housewife's scouring pad except silver plated – designed for high heat applications, according to Dr. Leslie Silverman of Harvard University School of Public Health.

---

150 Tons Gas-Fueled Cooling

Things to come? A 150-ton centrifugal compressor, driven by a piston engine using natural gas as the fuel, is used to chill water for the cooling system at Milwaukee Gas Light Company's main office building.

Cost to operate . . . at 6 cents a therm, equal to what would be charged if electricity could be purchased at less than one cent per kilowatt hour, according to the firm's vice president for sales, Bruce A. McCandless. Compressor by Carrier, motor by Waukesha.

From Behind the "Iron Curtain," New Lead Dust Data

According to a recent issue of the Hungarian Review, a new method to protect workers at the Metallochemia Works in Hungary against "noxious effects of lead dust" has been developed by Dr. Kapolnai, the factory's physician.

The medicine . . . a copper containing drug that is claimed to eliminate lead from the system. Every worker assigned to a hazardous job is given 100 tablets of the medicine each month, which costs the factory nearly 1000 forints (about $3000.00) annually.

The results . . . in 1955, 2,656 work days lost due to lead poisoning . . . in 1958, 980 work days lost for the same reason, according to Hungarian Review.

63-million Dollars In 22 Years for Air Pollution Control

That's how much huge Consolidated Edison Co. of New York has spent for air pollution control since 1937 for their myriad generating plants in and around New York City. Last year the utility spent $6,000,000 on this program.

Standards for Pure Air To Be Legislated?

In California, Governor Brown's nonpartisan Commission on Metropolitan Area Problems decided to concentrate on smog. The Governor has told the agency he wants its advice on standards for pure air and for control of exhaust (automotive) emissions, which are to be established by Feb. 1, 1960.

Research To Take Odor Out of Paper Pulp Industry

Using funds from a $60,000 grant by Hudson Pulp & Paper Co. to University of Florida, Dr. William J. Nolan, professor of chemistry and head of the pulp paper lab at the University, will carry his 10-years of research in odor control well into the pilot plant stage. Dr. Nolan said private industry had loaned or donated much of the material for the pilot plant, which would otherwise have cost $100,000.

General Motors To Study Auto Exhaust Cancer Link

G.M. has announced proposed research on whether or not auto exhausts do in fact cause cancer. Auto exhaust fumes have been long eyed as a potential cause of lung and skin cancer, eye afflictions and respiratory ailments. But there is as yet no conclusive proof relating auto exhaust emissions with these diseases.

G.M. officials indicate it is more practical to find out whether auto exhausts cause cancer, eye irritation, etc., than it is to spend millions for alleviants such as catalytic mufflers, special fuels, etc.

However, G.M., along with Ford and Chrysler, are working on emission control mufflers of one type or another.

At the same time, in Washington, the House Commerce Committee recently approved a bill authorizing a study of what effect exhaust fumes from motor vehicles have on health. The measure directs the U.S. P.H.S. surgeon general to make a study and report to Congress within two years.

Proposed G.M. study would be done by Sloan-Kettering Institute for Cancer Research and would be the first such project to be financed by a single auto manufacturer. Program calls for continuous analysis of heavily laden air in Times Square, New York, in less concentrated areas and in commercial and residential buildings.

Kaiser's Employee Air Pollution Incentive Plan

At Kaiser's huge Fontana, California integrated steel plant, employees are paid a salary bonus for contributing to the plant's air pollution abatement plan by efficient equipment operation.

How it works . . . Kaiser air pollution control department engineers set emission standards from each operation – open hearth, coking ovens, oxygen steel-making furnaces, sintering plant . . . then check each operation from time to time. If at time checked, emission meets Kaiser standards, that department's employees automatically get the bonus.

New $50 to $100-Million Dollar Dust Collection Equipment Market . . . Chicago

Best educated guess as to effect of tough new Chicago Air Pollution Control Ordinance is that Chicago industry, including metallurgical plants, will spend $50 to $100-million dollars for dust collection, fume abatement and other air pollution control equipment over next ten years.

Answer To Coalman's Prayer???

Soon to be announced . . . a new modulating type coal feed control for underfeed stokers. Unit is said to be able to reduce cut-off period by 90 percent, thus reduce air pollution, promote more efficient firing, squeeze more heat btu's out of coal.

Shall We Lobby for Another Law?

Air conditioning definitely increases labor productivity. That's a conclusive and definitive report of the General Services Administration of the U. S. government. Based on a controlled study of its own employees, this is what GSA found: A substantial average increase in work production (9.5 percent). A slight decrease in errors (0.9 percent). A measurable decrease in employee living expenses (savings on cleaning bills, hairdos, cosmetics, etc.). An important contribution to employee comfort and morale. "It is safe to assume that in any other type of office work, where the rate of production is not standardized, or where no minimum requirement must be met consistently, the increase in productivity will be more than enough to pay for air conditioning through savings in employee salaries," the GSA report pontificated. Hooray for our side!

AIR ENGINEERING

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EDITORIAL:

Municipal vs. Residential, Apartment House Incineration . . . The Battle Is On!

In New York, Toronto, Ontario, Canada, Chicago, Detroit, war is being waged in the burning of trash, garbage, combustible wastes by homeowners and apartment house operators.

In New York, as we go to press, a ban against apartment house incinerators is being considered. Right now a law soon to take effect in that city will require apartment house owners to up-date their incinerators so they will meet emission requirements. Which is worse (most costly), to pick up garbage and trash and thus boost the workload of the city's able Department of Sanitation, and thus reduce the health hazard . . . or chance the health hazard and let the apartment house incinerators burn merrily on, is the question.

The 11,000 apartment house incinerators in New York are said to incinerate, more or less, about 800,000 tons of refuse yearly, about one-third of the city's total refuse.

In Toronto, Saskatoon, Vancouver, other Canadian cities, gas utilities are boosting gas-fired home incinerators with big ad campaigns. Ads point out convenience to home owner, how units reduce air pollution, end garbage collection, wipe out problems of messy, smelly, unhealthy garbage storage.

The utility's campaign makes Toronto's chief air pollution control officer, H. A. Belyea, shudder. Says he, "if domestic incinerators are installed in Toronto homes, it will be over my dead body. Some cities have allowed them and they have been extremely sorry." They work fine in the laboratory, but says Belyea "He (the average householder) is not going to stand around and watch it. His kids are going to use it. He is going to forget to turn on the gas. The incinerator will get old and not work as well." The results, in Belyea's opinion . . . more instead of less air pollution. And effluents, he feels, could be sucked down into a neighbor's kitchen window . . . a not very appetizing prospect. He concluded: "air pollution division of Toronto would have to put on an extra staff of say 50 men, which might cost $200,000 a year."

Belyea feels a municipal incinerator, operated by trained personnel, is the answer.

Saskatoon city council has worked out a plan so homeowners can buy gas-fired incinerators. Cost of around $110 may be financed by a city contribution of $10 per year for five years as a rebate on taxes to compensate for reduced garbage pickups. Remaining $60 would be paid by homeowner by a $1.00 surcharge on his monthly gas bill. While homeowners

(Please turn to page 8)

increase production capacity . . .
improve fan and heating efficiency

with

gas-fired
air
make-up
units

Pictured above is a portion of the final assembly line at Aerovent showing 8 units slated for delivery to a large Midwestern automobile accessory manufacturing plant. Designed to supply ample quantities of clean, pre-heated or cool, outside air to replace air exhausted by ventilating systems, the Aerovent Gas-Fired Air Make-Up Unit keeps air fresh; eliminates drafts and negative pressures. Safe, dependable operation and automatic, semi-automatic or manual control with natural, mixed, manufactured or propane gas.

For winter or summer use, these compact, packaged units are available in four unit arrangements and four sizes from 36" to 54" for various capacities, BTU ratings and pressure conditions.

Write for bulletin 880.

OTHER UNITS AVAILABLE FOR STEAM OR HOT WATER

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

Aerovent

FAN COMPANY, INC.

Ash and Brian Streets Piqua, Ohio

Letters

(Continued from page 2)

fumes is to blow them straight up in the air, and that means remove the caps.

4 – The stacks as shown offer resistance, and why add more resistance to the system?

5 – Amount of snow which might fall into open stacks is of small consequence and gravity effect of warmer air inside building, flowing up through stacks when plant is closed, definitely help to melt this.

6 – I have dozens of fans on exhaust systems with uncapped stacks and have never had a complaint about rain entering building through stacks. Simplest thing is to place housing drain in fan.

I'm all for our starting a campaign to remove the caps from exhaust stacks on fans. They do no good, they cost money and they do a lot of harm.

A. G. Mutimer
Registered Engineer
Jenkintown, Pa.

Editor:

Congratulations on this excellent, timely and greatly needed publication and its approach to the most effective means of scientific control of air pollution and conditioning. Vol. 1, No. 2 just arrived. Please send Vol. 1, No. 1.

Charles P. Treer, President
Aerosol Engineering Corp.
Houston

Editor's note:

Since the appearance of the first issue of AIR ENGINEERING *in April, so many later subscribers have asked for this first issue to complete their files that we are now completely out of stock. So the April issue is no more and even your editor has to keep his last two copies tucked away.*

Editor:

Congratulations on a very fine magazine. I should like to see an article on filter media for cleansing air-cloth of various kinds and on air cleaning by the new contact or impingement method.

Marion F. Trice
American Embassy
Bogota, Colombia, S. A.

Editor's note:

If you have an idea, or a need for specific technical material you would like to see covered in an article in AIR ENGINEERING, *use the addressed, postage-free cards in the Communication Center on page 37.*

Use the addressed, postage paid cards in the Communications Center, page 37, for more information on new products, your comments about editorial material in this issue, suggestions for topics to be covered editorially, etc.

New PRODUCTS

Fiberglas Power Roof Exhauster

First power roof exhauster molded in reinforced Fiberglas claims structural strength equal to steel and greater impact strength than either aluminum or steel. It will not dent.

"Super/Air-Van" is constructed of sound absorbing and dampening material unaffected by salt spray and resistant to most common acids, gases, and moisture-laden air.

Super/Air-Vans incorporate patented scroll design to give efficiency to 4 in. sp. Motor is out of air stream and protected by patented air seal-off which creates a curtain of fresh air under negative pressure around motor shaft.

Unit features low installed silhouette with 4 in. maximum curb. Capacities range from 100 to 11,000 cfm.

Source: *Gallaher Co., Dept. AE, 4108 Dodge St., Omaha, Neb.*

'Wall-Line' Perimeter Air Conditioning

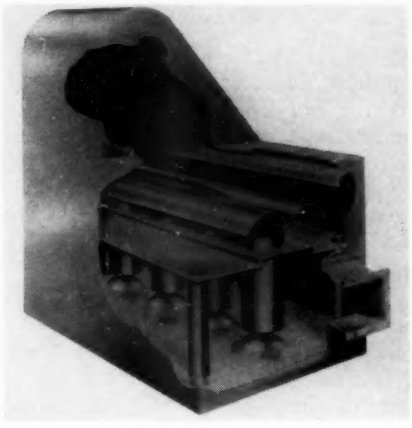
"Wall-Line" perimeter air conditioning is a UniTrane air conditioning unit with pre-assembled ducts which circulate conditioned air along exterior walls.

Air conditioning effectiveness is always the same in the room even if interior partitions and walls are moved because architects or engineers can design a system on a btu/hr ft and cfm/ft basis that will be maintained for the whole room.

Ducts extending air outlets along the full perimeter of the room also make it possible to reduce the number of air conditioning units with one unit of larger capacity and provide better air circulation.

New "Wall-Line" air conditioning can be used in combination with a separate duct supply of conditioned ventilation air, or as an independent air conditioning system.

Source: *The Trane Co., Dept. AE, La Crosse, Wis.*



Wet Dust Collector

A new concept of hydrostatic dust collection employs a circular venturi introducing a mixture of dirty gas and water mist into a vertical cylinder. The cylinder permits a longer retention period of the dusty air in the cleaning element thus increasing the probability of water and dust particle collision.

The water is removed from the air stream by a circular baffle which is in itself an excellent dust impingement surface. By venturi variations the "Mist-O-Miser Dustraxtor" can meet any wet collection application.

Dust disposal arrangements include: Flat bottom hoppers for manual cleaning; triangular hoppers for continuous flushing; chain and paddle scraper for flat hopper sludge removal; and separate settling hoppers with any of the previous mentioned arrangements.

Materials of construction are varied to meet particular collection applications involving acid or alkaline conditions. Ceramic, porcelainized steel, or stainless steel collector elements are available.

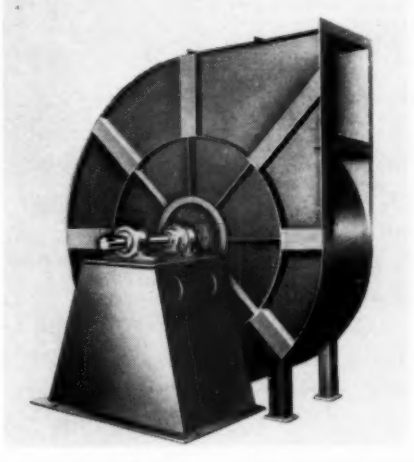
Source: *Fly Ash Arrestor Corp., Dept. AE, 277 N. First St., Birmingham 1, Ala.*

Airfoil Pressure Blowers

New series of high-efficiency, large-capacity pressure blowers equipped with airfoil blading has 8,000 to 64,000 cfm at pressures from ¾ to 2¼ psig.

These airfoil pressure blowers are suited for steel mill furnaces, product cooling, pressure or vacuum drying, liquid agitation, glass blowing and cooling and similar industrial applications.

Statically and dynamically balanced blower wheels are completely stress relieved. A rising pressure characteristic plus inlet air spin control give stable air volume delivery for normal operating ranges and at reduced loads.



Source: *Westinghouse Sturtevant Div., Dept. AE T-257, 200 Readville St., Hyde Park, Boston 36, Mass.*

(Please turn to page 12)

Use Communications Center, page 37, for requesting more information about articles, advertised products, literature, and for comments about any of the editorial material in this issue of AIR ENGINEERING.

NEWS of the Industry

Auto Fumes Hit Smoke Garage Workers Hardest

Smokers who inhale and garage mechanics are among the most likely prospects to feel the effects of auto fumes, according to a report in the official journal of the U. S. Public Health Service.

"Smoking and exposure to auto exhaust are so common that a very large number of persons are affected in such a way that up to 8 percent of their hemoglobin is unavailable for oxygen transport," the report said.

Such impairment of the oxygen supply could have serious consequences for persons with failing hearts and poor brain circulation, the report indicated.

Weston Air Conditions Close Tolerance Area

A lap and hone area which will be air conditioned to permit measurement of products to close tolerances will be a part of the multi-million-dollar plant being built by Weston Hydraulics, Ltd. in Van Nuys, Calif.

Many of the products produced by Weston, a subsidiary of Borg-Warner Corp., "involve dimensions which must be measured to the nearest five-millionths of an inch," a company spokesman pointed out.

The air conditioning system for the room will include an electronic air cleaner, and will control the temperature at 71 F plus or minus 1°, with a maximum relative humidity of 40 percent.

Bead of Sweat=Boom At Atlas Missile Base

Nearly half the cost of a $30 million Atlas intercontinental ballistics missile base goes into the maze of valves, tanks, pumps, and piping of the propellent loading system, all of which must be fabricated and assembled under extreme clean air conditions, reports *Engineering News-Record.*

Liquid oxygen, helium, nitrogen, and kerosene are the four highly dangerous fuels the loading system handles. A fragment of tobacco, a bit of lint, or a bead of sweat dropped into liquid oxygen and—boom! An explosion.

For this reason, all parts of the system are bathed in several types of acid and cleaning agent after fabrication. They are examined for sterility and cleanliness with black light, electronic probes, and light tests, and then sealed into polyethylene bags.

Workers are not permitted to eat or smoke in assembly areas. All employees must wear plastic gloves to prevent fingerprinting parts. In the cleaning section, employees must wear lintless clothing, rubber shoes, and linen headcloths.

Readers with clean air problems can get a 16-page reprint of "The meaning of Clean Air" by Robert H. Avery, director of application engineering for Cambridge Filter Corp., by requesting a free copy on the editorial service card in the Communications Center on page 37.

Cleaner Air Week Oct. 25-31

Cleaner Air Week will be observed throughout the country for the 11th time Oct. 25 to 31. Sponsored by the Air Pollution Control Association, it attempts to broaden public understanding of the air

Editorial *(Cont.)*

Incineration . . . Municipal vs. Apartment House

(Continued from page 5)

don't *have* to buy the incinerator, they still have to dispose of their own garbage under the new greatly reduced pickup system . . . so an incinerator is virtually necessary.

Same situation will, it is rumored, also exist in Vancouver.

Air pollution officials in both cities share Toronto's H. A. Belyea's shudder, feel unskilled homeowners will increase the air pollution problem.

We feel the makers of big, municipal incinerators should be more alert to the tremendous market waiting for their products throughout the country. It's a well known fact that most cities of any size at all have severely inadequate municipal incineration facilities, if indeed they have any such facilities other than land fill at all. In New York, Chicago, Detroit, big and little towns, it's the same story.

Yet the makers of municipal systems are allowing the gas utilities, the makers of residential gas-fired incinerators, to run rings around them with big local campaigns, public relations pressure on city councils, magazine articles, every medium of mass communication to the private homeowners.

Not to be forgotten, too, is the vast private industrial incineration market. Waste burning, scrap copper wire reclamation, wood waste disposal, are all ripe markets . . . for today's industry is anxious to meet air pollution codes, maintain good local public relations, and last but not least save haulage money by operating their own disposal plant.

From the end of World War II to today, the market for industrial and municipal incinerators has climbed from a paltry $7-million to a $30-million dollar business. What the total sales *could* be is anybody's guess . . . safe to say, with more aggressive promotion, public relations and advertising, sales *could* be doubled.

Coming . . . in AIR ENGINEERING *soon, a complete study of the problem of municipal vs private and apartment house incineration. Meanwhile, manufacturers of all three types of incinerators are invited to send their comments to the editor.* ▲▲

pollution problem and focus community attention on the service rendered by local public officials responsible for air pollution control.

President Dwight D. Eisenhower endorsed the 1959 observance with this message:

"The eleventh annual observance of Cleaner Air Week brings emphasis to bear upon the need for a broad public effort to understand and control the hazard of air pollution.

"Activities connected with this observance call attention to the research and control programs carried out by both private and governmental groups.

"By encouraging better understanding of existing and potential hazards to the air we breathe, your committee is contributing to healthier living for us all."

Charles N. Howison, general chairman of the APCA committee in charge of the observance, added:

"The measure of success this campaign has enjoyed in educating the American people to a sound approach to air pollution control has special significance, we think, for industry.

"Public acceptance of, and participation in, the 'Cleaner Air Week' program indicates not only that the public wants information about air pollution causes and controls, but in addition, possesses a considerable capacity for understanding the complexities of the whole problem."

Gold Mine Removes Dust 3,000 Ft. Down

How a South African gold mine solved a dust control problem 3,112 ft. below the surface was described at a recent conference on dust and ventilation sponsored by the Mines Accident Prevention Association of Ontario.

J. R. Hall, ventilation engineer, explained that Hollinger Gold Mines, Ltd. solved its problem by enclosing the sources of dust at an underground loading station as tightly as possible, installing a dust filter, and recirculating the air.

The company spent $7,605 for the equipment and its installation and spends about $100 a year to maintain the filter. But it has reduced dust count from 400 to 1,100 ppcc to 84 to 216 ppcc.

The filter, with 2,400 sq. ft. of filtering area, handles four skip compartments which hold 6½ tons of ore each. Discharge end of feeding conveyor and entrance to loading pocket are enclosed by a housing. Dusty air is withdrawn from it through a bag filter connected to a 2,000 cfm exhaust fan.

While skip is being loaded, a hood above it confines dusty air, which is drawn through a cloth filter by a 3,000 cfm Sirocco fan.

Dravo Air Conditioner Is Now 'Correct-Air'

James Campbell Smith, Inc. and its subsidiary, Correct-Air Corp., both of Willoughby, Ohio, are now manufacturing and selling the former Dravo air conditioner for pulpits and crane cabs.

The units are sold under the "Correct Air" trade name.

Odor Patrol Part of Good Neighbor Policy

How a large chemical plant sets up personnel and physical facilities to provide odor and smoke control and thus be a "good neighbor" in its community is related in a recent company publication of Lederle Laboratories, a division of American Cyanamid Co. in Pearl River, N. Y.

"Every evening," the article begins, "Dick Clendenny or Harry Everson of the Industrial Waste Department takes a tour of the plant—to make a sniff test at 16 locations. If the man on the "odor patrol" notices an unusual odor, he checks at the location involved.

"The odor patrol was one of the recommendations made by a special 16-man committee whose goal is to coordinate a program of finding ways to minimize or eliminate odors and smoke. The committee is composed of representatives from production areas, research groups, engineering, yards and roads, industrial waste plant, and community relations.

"The men on the committee review any odor and smoke complaints that come from residents or employees. (Complaints are followed up just as soon as they are reported.)"

Out of these discussions, says the Lederle publication, come recommendations for various changes and additions in facilities—such as in cleaning tanks, and in incinerators to increase efficiency. During the past year, the company spent $100,000 for a second aeration tank and other items.

(Please turn to following page)

Dwyer
CONTROLS GAGES

AIR VELOCITY METER
No. 400

One Instrument Tells Both Air Velocity and Static Pressure!

- Reads directly in feet per minute and inches of water.
- Check *all* velocities from 400 to 10,000 F.P.M.
- All static pressures from 0 to 10" of water.

Tests fan and blower discharge and inlet pressures, pressure drop across filters, balances air conditioning systems, etc. Complete kit includes dual purpose manometer, 18" stainless steel pitot tube, Magneclip mounting panel and all necessary fittings, tubings, instructions and accessories.

Write today for literature and prices.

F. W. DWYER MFG. CO.
P.O. Box 373-A Michigan City, Ind.

NEWS of the Industry. . .

(Continued from preceding page)

Biggest for Publisher, First for City Hall

The largest heat pump system in the country—as of now—will be installed in a new $5 million publishing house now under construction in Huntington, Ind., according to Carrier Corp. Baker-McHenry Co., mechanical contractor of Indianapolis, will install three Carrier 500-hp. water chillers in the building next spring.

Carrier believes this will be the first printing establishment—it will print the national Catholic newspaper "Our Sunday Visitor"—served by a major heat pump installation.

Meanwhile, York Corp., Div. of Borg-Warner Corp., announced it will provide an air-source heat pump for the new Springfield, Ill., municipal building. York claims it will be the first major municipal building in the country to use heat pumps for year-round air conditioning. Some 200 hp. of electricity will be required to run the equipment, according to York.

Teeth, Tea, and Strontium-90

Two Canadian dental researchers believe that a history of radiation absorption by human beings can be found in human teeth. Because teeth, unlike bone structure, do not go through any cellular replacement after they mature, they are the perfect radiation measuring device.

The two scientists, Dr. Murray Hunt and Dr. Gordon Nikiforuk of the College of Dentistry at the University of Toronto, have been collecting children's teeth from public health departments since 1945.

After sorting, cutting, and grinding them, they believe they have a record of the effect of radiation since the first atom bomb went off.

In the meantime, two Japanese scientists are prepared to report to the American Pharmacology Society in Cincinnati on Aug. 19 that tea can be an antidote to the effects of strontium-90.

Dr. Teiji Ugai, president of the Shizuoka Pharmaceutical College, and Dr. Eiichi Hayashi, also of the college, have conducted experiments for two years on white mice after learning that radiation victims of Hiroshima and Nagasaki reported they felt better after drinking tea.

Tea, they found, absorbs strontium-90 and eliminates it before it reaches the bone structure.

Chemical Disinfectant Is 80% Effective

A new chemical disinfectant system that is claimed to be more than 80 percent effective in eliminating infectious agents from hospital wards was described by Dr. Perry Hudson, chief of the urology service at Columbia University's Delafield hospital at a recent medical conference in Albany, N. Y.

This new system was described as being essentially a "new version of old-fashioned anti-sepsis." It involves covering all surfaces, and cleansing the air, with powerful new anti-germ chemicals. These are organo-metallic compounds, in which the active ingredients are either silver or tin.

These compounds are introduced into air recirculation filters, and laundry rinse waters, and are even impregnated into plastic mattress covers. They are also blended into floor wax and window-cleaning preparations, and sprayed on ward furniture, walls and ceilings.

In effect, Dr. Hudson explained, the hospital is converted into a collection of sef-decontaminating areas, in which infectious microbes cannot survive for more than moments. The new system was developed in collaboration with Dr. Grant Sanger and Dr. Edith Sproul.

Board Hears Comments On Pollution Control

At a board meeting last month California's six-county Bay Area Air Pollution Control District (San Francisco) listened to comments and requests on proposed Regulation 2, designed to control emissions from industrial, incineration, heat and power generation sources.

Speakers at the meeting, representing industry, asked the Board for: "separate consideration" for the smelting industry because certain rules were physically or financially unfeasible; adoption of the Los Angeles incinerator standards; full industry participation in ground level monitoring, subject to control and policing by the BAAPCD Control Officer.

States Take Steps To Curb Air Pollution

The States are beginning to take individual legislative action about air pollution, some weak, some less so.

In Illinois, the state legislature has sent to the governor for signature a bill to create a State Air Pollution Study and Investigation Committee.

In Pennsylvania a compromise air pollution bill was introduced in the State legislature. Principal feature of the measure, a partnership-type arrangement between the state and proposed regional air pollution commissions to carry out control proposals. The control regions would be superimposed on the seven State Health Department regions in the state, with each region supervised by a commission with powers to persuade compliance rather than to enforce them.

In Florida, the State's air pollution commission is battling airborne fluorides from phosphate processing plants. And according to the Florida State Board of Health, the problem is rough in Polk County, producer of 75 percent of the world's phosphate. In Polk County, the Board says, fluorides have harmed citrus crops, injured cattle. Fluorides, say the Board, settle on grass, cause cattle's teeth to become soft, wear down to gums, so cattle can't chew food, become emaciated.

Florida's air pollution commission has set the outdoor air fluoride content at 40 parts fluorine to 1,000,000 parts of vegetable matter, which they believe will solve the problem if phosphate plants can control emissions to meet this MAC.

In South Carolina, U.S.P.H.S. officials met with county health officers and representatives of the North Area Pollution Committee to determine health hazards, if any, of odors from plants in the Charleston area.

In New York-New Jersey metropolitan area, a coordinated program for reduction of air pollution has been started by the two states. The agencies involved are the New York City Department of Air Pollution Control, the New York State Board of Air Pollution Control, the New Jersey Air Pollution Control Commission, and the New Jersey Department of Health.

Pollution Complaint$

Where there's a pollution problem there's a market for equipment to solve that problem . . . dust collectors, scrubbers, precipitators, blowers, other equipment.

Each month we plan to summarize air pollution situations in cities across the land as a service to equipment manufacturers.

We also plan to follow-up directly with each company involved to cover the solution to their problem as a service to our readers.

Buffalo, N. Y.—Local air pollution control officials, civic groups, individual citizens, have initiated action to end claimed air pollution and odors from the Socony Mobil Oil Co., Inc.'s Buffalo refinery, and the National Aniline Div. of Allied Chemical Corp.

Thomas C. Lockhard, manager of the Buffalo refinery, said many of the complaints are legitimate and that "We will do everything reasonable to do away with nuisances for which we are responsible." George F. Brandt, chief chemist for the refinery, said industry does not as yet know how to test for some forms of air pollution.

James F. Day, manager of National Aniline Div., said: "We want to be good neighbors. We're doing everything we can to cut pollution."

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Louisville, Ky.—Local air pollution control authorities, civic groups are assured relief soon from smells, eye irritation, raw throats from quick-cure dark tobacco operations at the Campbell Tobacco Co. The tobacco is mainly for export, most going to South Africa.

Plant officials are trying to reduce the nuisance by spacing operations and by installing better venting equipment, according to Ralph W. Bourne, chief engineer for the City-County Air Pollution Control Commission.

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Portland, Ore.—Chipman Chemical Co., 6200 N.W. St. Helens Rd., which has spent more than $100,000 to control fumes from its plant, is spending another $50,000 for more of the same equipment, according to B. J. Smith, vice president. Plant makes weed killers.

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St. Johns, Ore.—Union Carbide plant has substantially reduced its "smog particles" by installing two furnace covers. The Esco Electric Steel Co. has installed "considerable" filter equipment.

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Albany, N. Y.—Watch legislative developments in this capital city. Governor Rockefeller brought temporary relief to industrial and commercial building owners by stating that he had not decided whether to recommend legislation requiring that a shelter against nuclear fall-out be constructed in every building in the state.

The Governor, in news conferences, said he would have to discuss the matter with legislative leaders and staff officials before drafting a bill for the 1960 legislature. However, he had endorsed, in principal, such a plan, submitted to him by his Special Task Force on Protection from Radioactive Fallout. The report called for a state law requiring protective shelters in virtually every building in the state, old and new, including residences. The Governor said: "If the concept can be worked out, I think it would be very much in the interest of the people."

Civil Defense authorities, on Federal, State and Local levels, endorsed the plan enthusiastically.

Such shelters would cost upwards of $500.00 for homes, and more for other types of buildings. If this legislation is adopted in 1960, look for a big market for filters, blowers, activated charcoal air purifiers, air moving equipment and air cleaning equipment of all types in New York State.

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Lynchburg, Va.—City officials, including Dr. J. T. T. Hundley, public health and welfare director, are hot on the trail of overpowering sulfurous odors which drift across the city on hot, sultry nights. Cause of odor is as yet undetermined. Odor is said to cause eye irritation. City officials believe odor originates in the heavily industrialized lower basin along the James River. When they find it. . . .

Meetings, Courses, Expositions

American Chemical Society, 136th national meeting, *Atlantic City, Sept. 13-18.*

U. S. Public Health Service training course in community air pollution, *Robert A. Taft Sanitary Engineering Center, Cincinnati, Sept. 21-Oct. 2.*

Instrument Society of America, 14th annual Instrument-Automation conference and exhibit, *International Amphitheatre, Chicago, Sept. 21-25.*

American Institute of Chemical Engineers meeting, *St. Paul hotel, St. Paul, Minn., Sept. 27-30.*

Federation of Sewage & Industrial Wastes Association meeting, *Statler-Hilton hotel, Dallas, Oct. 12-15.*

National Society for Clean Air, Diamond Jubilee International Clean Air Conference and Exhibition, *London, England, Oct. 20 to 23.*

Oil Heat Institute of America, Inc., board of directors meeting, *The Homestead, Hot Springs, Va., Oct. 28-30.*

Association of Consulting Chemists and Chemical Engineers meeting, *Biltmore hotel, New York City, Oct. 28.*

Industrial Hygiene Foundation annual meeting, *Mellon Institute, Pittsburgh, Oct. 28-29.*

Air Conditioning and Refrigeration Institute, 11th Exposition of the Air Conditioning and Refrigeration Industry, *Public Auditorium, Atlantic City, N. J., Nov. 2-5.*

U. S. Public Health Service training course in control of particulate emmissions, *Robert A. Taft Sanitary Engineering Center, Cincinnati, Nov. 2-13.*

Institute of Boiler and Radiator Manufacturers semi-annual meeting, *Seaview Country Club, Absecon, N. J., Nov. 9-13.*

U. S. Public Health Service training course in control of gaseous emissions, *Robert A. Taft Sanitary Engineering Center, Cincinnati, Nov. 16-20.*

American Society of Industrial Hygiene annual meeting, *War Memorial building, Rochester, N. Y., April 25-28, 1960.*

Production Engineering Show, *Navy Pier, Chicago, Sept. 6-16, 1960.*

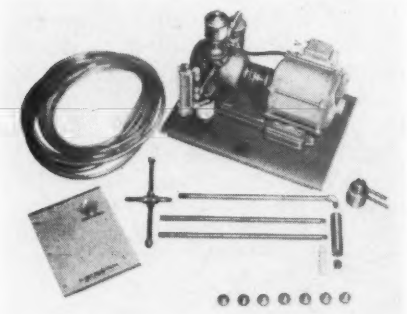
East Central Section, Air Pollution Control Association, *Sheraton-Cadillac Hotel, Detroit, Sept. 22-23, 1960.*

(Continued from page 7)

Iso-Kinetic Dust Sampler

Iso-Kinetic dust sampler is designed to measure dust particles discharged from dust control equipment and to determine equipment operating efficiency. This equipment has been used by DAY for many years in conducting field tests to determine dust conditions in plant dust control systems. It is now available to companies who wish to conduct their own dust control measurements.

Sampler will accurately measure grains of dust passing through dust



control ducts, or will measure particles being discharged from dust control equipment; such as cyclones and other equipment which exhaust to the atmosphere.

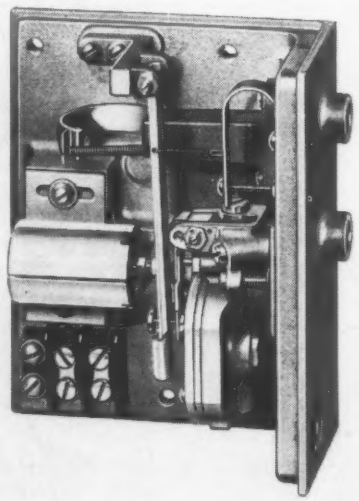
Complete assembly consists of a rotometer, air-line filter, air pump, oil reservoir, oil trap, electric motor, plastic air-line tubing, rod handle, graduated rod, filter thimbles, thimble holder, thimble ring seals, and nozzles. Instructions and charts are included.

Source: *The DAY Co., Dept. AE, 810 Third Ave. N. E., Minneapolis 13.*

Load Limiting Relay

Protection for motors of centrifugal refrigeration compressors from overload on "start-up" is provided by new load limiting relay. It is designed for pneumatic control systems and may be used with all makes of compressors.

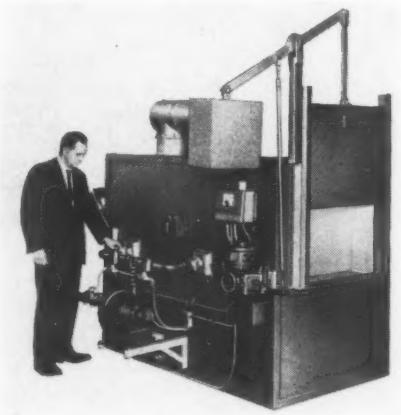
The new relay is connected in the control line to the suction damper operator and limits the output capacity of the compressor



to the full load motor ampere rating. The V-26 can be adjusted for any current value between 3 and 7 amperes. With the proper transformer, the load limiting relay can be used to control compressor motors of any size.

The device consists of an electrical element, a standard Johnson pneumatic direct acting proportional action relay and a feedback element. The V-26 may also be applied to fans and pumps.

Source: *Johnson Service Co., Dept. AE, Milwaukee 1.*



Incinerator Door Opener

Electric door-opener and closer is available at slight additional cost on all Winnen custom-built industrial and commercial incinerators. The door opener is for use with the guillotine type door.

Source: *Winnen Incinerator Co., Dept. AE, 932 Broadway, Bedford, Ohio.*

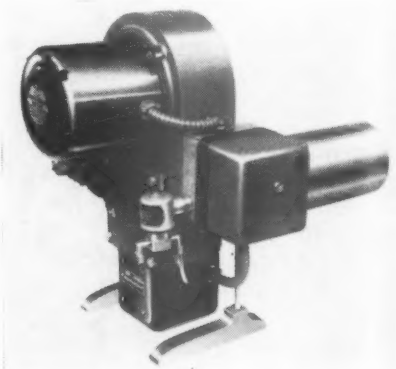
Patching Cements for Filter Fabrics

Vicel, a solvent type cement, patches tears and holes in centrifuge bags and rotary filter cloths. Nycel, a two component epoxy cement gives exceptional strength for centrifuge bags and dust collection bags.

Vicel dries by evaporation of the solvent leaving a tough film of acrylonitrile-vinyl chloride copolymer that resists concentrated acids and alkalies. It will not leach out and has good adhesion to spun staple synthetic fibers and cotton.

Nycel has a tensile shear strength of 2,000 lbs/in. when cured at room temperature. It has fast curing time and resists acids, alkalies, and solvents. It adheres even to monofilament yarn fabrics.

Source: *Technical Fabricators, Inc., Dept. AE, 136 Washington Ave., Nutley, N. J.*



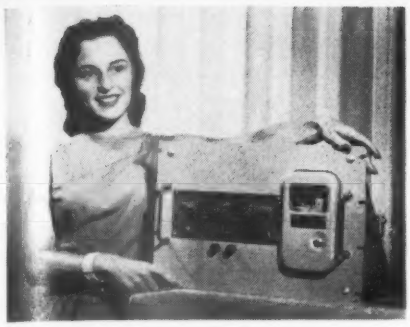
Power Gas Burner

Commercial and industrial power gas burner for conversion of coal or oil furnaces and boilers to gas is made in 400,000, 700,000, and 1,000,000 Btuh input capacities.

M-H electronic safety controls are standard equipment. Main gas valve will not open until pilot flame is proven. Intermittent pilot burns only when burner operates.

One adjustment automatically allows proper amount of primary and secondary air.

Source: *Liberty Combustion Corp., Dept. AE, E. Molloy Road, Industrial Park, P. O. Box 300, Syracuse, N. Y.*



Rack Mounted Voltage Regulator

Rack mounted Inductrol voltage regulator can handle single-phase loads up to 8.5 Kva and 100 amperes.

Available either automatic or motor driven, this Inductrol voltage regulator features no brushes, introduces no harmful wave form distortion, and is unaffected by power factor, frequency, or load. Controls are drift-free, maintain ±1 percent bandwidth accuracy over a temperature range of -60 C to +60 C. Regulators are built to MIL-E 16400 and MIL-E-4158.

Source: *Voltage Regulator Product Section, Dept. AE, General Electric Co., Pittsfield, Mass.*

Indicates Relative Humidities Electronically

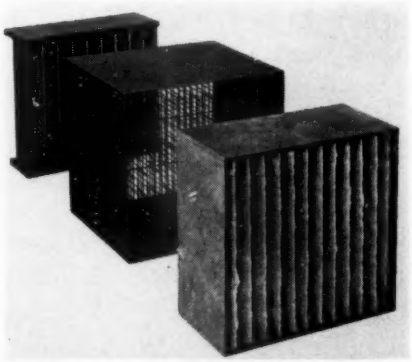
Portable Electro-Hygrometer indicates relative humidity electronically from as far as 100 ft. away. No tubes are used and readings are almost instantaneous.

Hygrometer is capable of indicating humidities from 30 percent to 95 percent, within a temperature range of 32 F to 180 F, by simply turning a knob. It operates with

an accuracy of ±5 percent. Wide variety of probes can be furnished in regular shapes or in long, flat shapes for special applications.

Panel control has a three position switch; Check, Off, and Read. When set on a check position, the meter reading is adjusted to 100 percent to compensate for any variations. A temperature correction factor for registering above or below 82 F is listed on the instrument.

Source: *Labline, Inc., Dept. AE, 3070-82 W. Grand, Chicago 22.*



Frame for Dust-Odor Filter

New combination "Aerosolve®" – charcoal filter frame, provides a compact filter bank for both dust and odor removal.

Upstream portion of this permanent steel frame holds a standard 12 in. deep Aerosolve filter cartridge in a choice of 95 percent, 85 percent or 35 percent discoloration efficiency on atmospheric dust.

The downstream end is designed for installation of an activated charcoal filter of the user's choice. The entire unit – frame, Aerosolve filter and activated charcoal filter – can be supplied by Cambridge as a complete package.

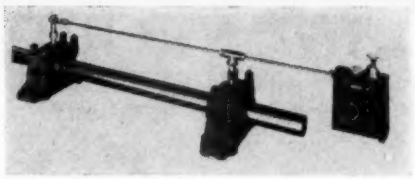
Unit has a capacity of 1000 cfm. Overall dimensions are 24 by 24 by 21 in. deep.

Source: *Cambridge Filter Corp., Dept. AE, 738 E. Erie Blvd., Syracuse 1, N. Y.*

Marlo Units Have Central Lubrication

Central lubrication system which oils all bearings simultaneously in a single operation is now standard, at no extra cost, on all Marlo air conditioning and refrigeration equipment with sleeve-type bearings.

In the forced feed system, the

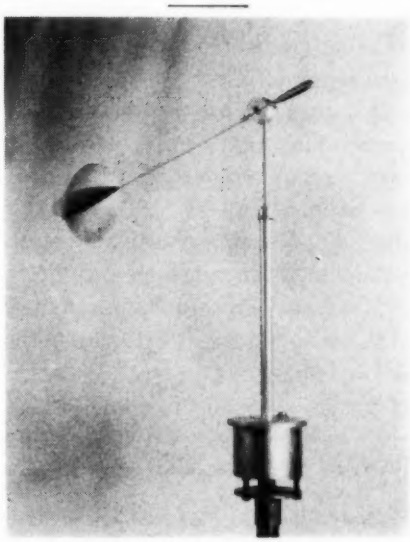


single pull of a plunger delivers a measured amount of lubricant from a central reservoir to all bearings at a pressure of 30 psi. On Marlo units with two or three bearings, a system with 60 cc lubricant reservoir holds 60 "shots."

On units with four or five bearings, a 150 cc system is used, providing 75 "shots" without refilling. Because the system is sealed and lubricant is filtered before it enters the distribution lines, no foreign matter can reach the bearings.

This is the first time that a centralized lubrication system has been applied to air conditioning and refrigeration equipment.

Source: *Marlo Coil Co., Dept. AE, 7100 South Grand Blvd., St. Louis 11.*



Rapid Response Bivane

Rapid response bivane accurately measures both vertical and horizontal wind components. Maximum over-shoot of this wind vane is 15 percent. A permanent record of this information is obtained on a companion recorder.

This high accuracy is necessary for air pollution studies, micrometerological work, and gas diffusion analysis.

Source: *Gelman Instrument Co., Dept. AE, Chelsea, Mich.*

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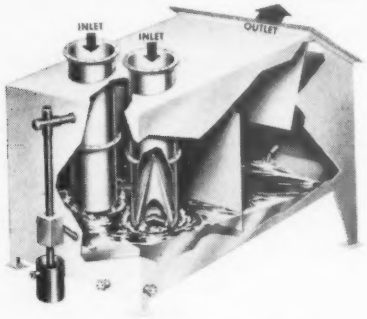


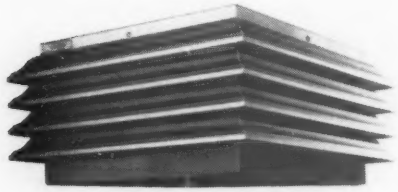
Turbulaire-Doyle Scrubber

Turbulaire-Doyle scrubber impinges dust-laden gas at high velocity into a pool of scrubbing liquid. High velocity impingement causes gas and dust particles to penetrate deeply into the liquid bath, producing dust collection efficiencies of 97 to 99 percent even on particles in the fume range.

Pressure drop is 5 to 10 in. of water and liquid ratio is 1 to 5 gpm per 1,000 cfm. Unit consists of sloping rectangular tank with impingement and eliminator sections separated by a baffle plate across tank at right angles to gas flow. Impingement section contains an overflow Weir for controlling fluid level and a gas inlet nozzle with cone for increasing gas velocity.

Complete unit to handle 15,000 cfm will measure about 6 by 10 by 8 ft. high.

Source: *Western Precipitation Corp., Dept. AE, 1000 W. Ninth St., Los Angeles 54.*



Low Silhouette Air Mover

Aluminum extrusions are designed to permit low outlet velocities on new low silhouette Wausau air mover. Housing is completely weatherproof. Point of discharge makes curb mountings unnecessary. Air stream is free of all braces and other obstructions.

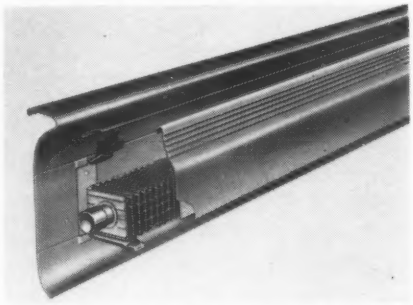
Bearing arrangement places fan wheel center of gravity between the bearings to provide a more rigid wheel suspension system.

Source: *Greenheck Fan & Vent Corp., Dept. AE, Schofield, Wis.*

Increased Rating for Baseboard Tubing

New ½ in. baseboard tubing for zone control hot water heating systems offers industry-approved ratings greater than those of standard ¾ in. tubing.

Edwards line of baseboard units now includes both the new ½ in. and the standard ¾ in. nominal tube sizes plus high-capacity units.



All are available in unbroken, factory-cut lengths from 2 to 20 ft. for fast, wall-to-wall installation. All covers feature Acousti-cover lining to minimize noise and are also available in copper-tone, chrome, flat white, or the new wood-grain finish.

Source: *Edwards Engineering Corp., Dept. AE, 101 Alexander Ave., Pompton Plains, N. J.*

Petroleum-Based Activated Carbon

National Carbon Co. has standardized on domestic petroleum-base materials, rather than imported cocoanut shell charcoal, for its complete line of Columbia brand activated carbon.

Activated carbon produced from petroleum materials is of comparable or superior quality and cost reductions make considerably lower prices possible.

Source: *Activated Carbon Sales, National Carbon Co., Dept. AE, 1300 Lakeside Ave., Cleveland 14.*

No Flying Metal Chips

The operator seen here is using a pneumatic die grinder to modify a cage casting for a special assembly. The grinder has a remote exhaust feature that keeps metal chips and oil mist spray away from the work area. The air is discharged at a point where the outer hose ends, several feet away.

Thomas C. Wilson, Inc., developed this feature as a means of increasing operator comfort and efficiency. The die grinder is part of a line of portable pneumatic grinders recently introduced by Wilson.

Source: *Thomas C. Wilson, Inc., Dept. AE, 22-12 44th Ave., Long Island City 1, N. Y.*

Bench Model Oven

New high-temperature bench-model oven offers excellent constancy and uniform values at temperatures ranging from 125 F to 1000 F. For example, a simul-

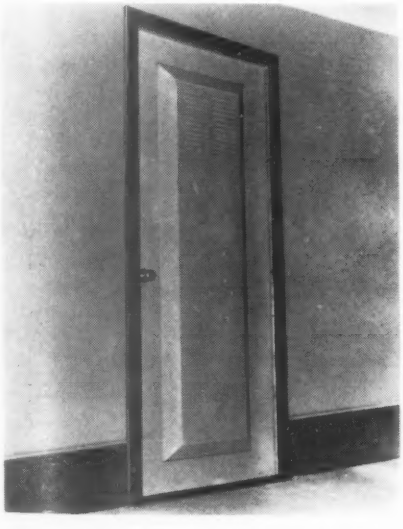
taneous temperature recording of eight thermocouples suspended 2 in. from the corners showed a uniformity of ±4 F at 1000 F.

Electric resistance heaters are located in all six walls (includes room, floor, and door), and are thermally weighted to produce maximum temperature uniformity.

Offering 4 cu. ft. work space in 34 by 33 in. bench space, new oven features front panel-mounted temperature controls, pilot light, fuses, and line switch. External straight line design permits oven stacking.

Operating on 230-volt power (11 amps. max.), the oven will heat up from room temperature to 1000 F in only 3½ hours.

Source: *American Instrument Co., Inc., Dept. AE, 8030 Georgia Ave., Silver Spring, Md.*



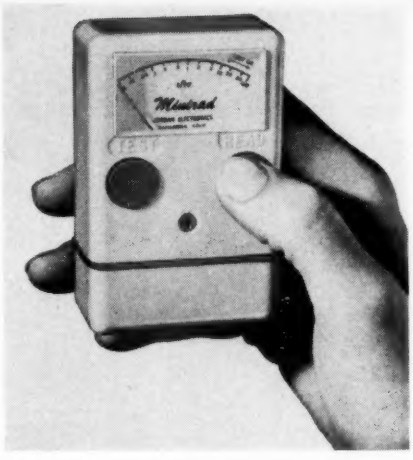
Sound Insulating Louver Door

Soundproof louver door combines qualities of a hollow metal door and a sound trapped air transfer duct.

Door permits air passage without sacrificing speech privacy in places where supply or return air has to pass freely.

It is furnished complete with frame, pneumatic and aluminum adjustable gasketing, and adjustable threshold sealing mechanism. Certified sound loss is 32 decibels, which is satisfactory for installation in a 4 in. masonry block wall.

Source: *Elof Hansson, Inc., Acoustical Div., Dept. AE, 711 Third Ave., New York City 17.*



Miniature Radiation Survey Meter

A gamma dose rate meter small enough to carry in the pocket is used to monitor radiation levels for safety of personnel.

Completely self contained, "Minirad" weighs less than 8 oz. It provides a wide range – from .005 to 50 r/hr in the Model M-50. Models M-100 and M-200 have respective ranges of .01 to 100, and .02 to 200 r/hr. This wide range logarithmic response is obtained without range switching.

Accuracy is ±30 percent of any dose rate on the scale. Only two pushbutton controls are required – one to test, and one to read. More than 30,000 readings can be made with one set of batteries.

Source: *Jordan Electronics, Dept. AE, 3025 W. Mission Road, Alhambra, Calif.*

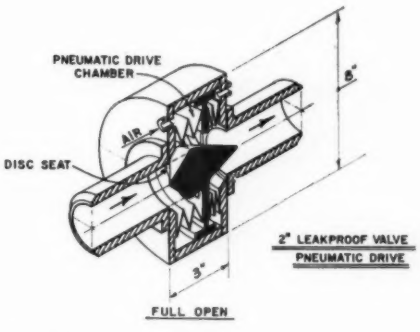
Refrigerated Unit for Compressed Air

"Refrigifilter," a new refrigerated unit designed to safeguard pneumatically-operated equipment from all forms of moisture, oil, and contaminants, will be introduced at the 14th Annual Instrument-Automation Exhibit in September.

Designed for locations where cooling water is unavailable, or where the ambient day-night temperatures vary a great deal, the Refrigifilter lowers the dew point of compressed air to approximately 35 F at pressure, thus condensing out over 90 percent of all moisture/oil vapors, and, at the same time, removing all entrained liquids.

Refrigifilter is rated at 100 scfm at 100 psig and 100 F and combines a heat-exchanger, evaporator, refrigerating section, and filter element all in one unit.

Source: *Hankison Corp., Dept. AE, College & Pike Sts., Canonsburg, Pa.*



Leakproof Valve

New, leakproof valve which has no moving parts between the fluid chamber and the atmosphere can safely handle radioactive and toxic fluids.

Suitable for either tight shut-off or automatic throttling of gases and liquids, the valve has negligible pressure drop across the closure disc. Internals can be made of any weldable corrosion resistant material, while externals may be of conventional brass or steel.

Limits of design working temperatures are -20 F to 1500 F; design working pressures range from 0.005 microns vacuum to 150 psig in smaller sizes, and to 30 psig in sizes up to 72 in. diameter.

Heart of the valve is a standard commercial bellows which forms the fluid chamber. The chamber contains only a seat and disk.

Singmaster & Breyer, designer of the valve, intends to make it available to manufacturers under licensing agreements.

Source: *Singmaster & Breyer, 420 Lexington Ave., New York City 17.*

Use Communications Center, page 37, for requesting more information about articles, advertised products, literature, and for comments about any of the editorial material in this issue of AIR ENGINEERING.

New Literature

Packaged Air Conditioners

A new eight-page illustrated three-color brochure (Bulletin 8525) describes the American-Standard line of packaged air conditioners.

The new bulletin describes and illustrates design and construction features. Capacities and physical data are presented in tabular form covering both air-cooled and water-cooled designs.

Source: *American-Standard Industrial Div., Dept. AE, Detroit 32.*

Btu Metering In Shopping Centers

New eight-page brochure entitled "Modern Shopping Centers and Btu Metering" by Kenneth S. Davidson describes large installations of Pollux Btu meters for accurately billing heating and cooling charges from central systems in large shopping centers. It details installation, operation, and maintenance.

Source: *Air Conditioning Equipment Corp., Dept. AE, 219 E. 44th St., New York City.*

Hazardous Vapors and Dusts

A limited number of free copies of a volume on "Hazardous Vapors and Dusts In Industry" compiled by Burgess H. Jennings in 1956, is still available from the Ventilating and Air Conditioning Contractors Association of Chicago.

The book covers hazardous materials and their physiological action; principles of supply and exhaust ventilation; threshold limit values; characteristics of individual gases, vapors, and dusts; and conversion factors.

The author interprets literature in the field of industrial hygiene and toxicology and puts it in a form suitable for use by engineers.

Source: *Ventilating & Air Conditioning Contractors Association of Chicago, Dept. AE, 228 N. La Salle St., Chicago 1.*

Manual on Airvec Condenser

Illustrated, 16-page manual details the installation, operation and advantages of the Edwards Airvec refrigerant condenser.

The manual includes a detailed explanation of Airvec's unique operating principle, specific operating advantages, installation instructions, head pressure control valve chart, suggested combinations of Airvec sections from 2 to 200 tons, trade prices, and detailed diagrams of typical Airvec installations.

Source: *Edwards Engineering Corp., Dept. AE, 101 Alexander Ave., Pompton Plains, N. J.*

Dust or Mist Collector

All basic information needed to select the most efficient dust or mist collector for the job is included in a new brochure offered by Aget Mfg. Co.

It includes all essentials, such as type and number of grinding, buffing, polishing or woodworking machines each model can service. It also includes detailed descriptions of accessory equipment.

Source: *Aget Mfg. Co., Dept. AE, Church St., Adrian, Mich.*

Use Communications Center, page 37, for requesting more information about articles, advertised products, literature, etc.

New Straight-Line Thermostat

Complete information on all General Electric room thermostats for heating and cooling applications are described in four-page illustrated bulletin, GED-3585A.

Performance characteristics, features, installation and wiring diagrams, photos and current rating of popular controls are given.

Source: *General Electric Co., Dept. AE, Schenectady 5, N. Y.*

Air-Over Fan Motor

Four-page bulletin, No. 2950, describes new line of air-over fan motors in ratings of 1 to 125 hp., enclosed and explosion-proof construction.

The motors are designed for operation in ventilating systems, exhaust systems, cooling towers, and all air moving installations where a motor drives a propeller or axial flow fan.

The bulletin gives application data for determining the motor horsepower rating required in an installation for various air velocities across the motor.

Motor dimensions and data on recommended maximum fan weight, thrust, and location are also given.

Source: *Louis Allis Co., Dept. AE, 427 E. Stewart St., Milwaukee 1.*

Noise Control Brochure

A 24-page brochure entitled, "An Introduction to Noise Control," offers a pictorial presentation of the many noise control products designed by Industrial Acoustics.

Included are noise control applications for air conditioning systems, the aviation industry, many industrial applications and soundproof rooms for medical and research fields.

Source: *Industrial Acoustics Co., Dept. AE, 341 Jackson Ave., New York City 54.*

(Please turn to page 20)

New Appointments

Appointment of **Robert G. Schreiner** as marketing manager—heat exchanger products has been announced by John W. Brennan, president of American-Standard Industrial Div. in Detroit.

R. G. Schreiner

In his new position, Schreiner will be responsible for sale and application of the division's line of shell and tube heat exchangers, feedwater heaters, and surface condensers.

He was formerly manager of the Industrial Div.'s Ohio Valley Region.

Trane Co., air conditioning equipment manufacturer, has announced the election of:

William C. Dackis as vice president, heat transfer sales.

William D. Graham, Jr. as vice president, sales offices.

John D. Cantwell, Jr. as vice president, La Crosse manufacturing.

The company also announced the appointment of:

William F. Dudek, manager of Seattle sales office.

James A. Driver, manager of a new sub-office in Orlando, Fla.

Joe Wharton to manager of the newly established sales office at Lubbock, Texas.

David L. Canfield as sales engineer of self-contained and residential air conditioning equipment in Detroit.

Baltimore Aircoil Co., Inc., manufacturer of evaporative condensers and cooling towers, has announced the appointments of:

B. McDougall

Ben M. McDougall as field sales engineer, working with BAC sales offices. He was formerly general sales manager of Kennard Corp.

Hugh B. Shepard as Maryland representative. He was formerly assistant sales manager.

Morris B. Older as controller to supervise financial operations.

Paller Engineering Co., Indianapolis, to represent BAC in central and northern Indiana.

George E. Fickett has been elected vice president and general sales manager for Powers Regulator Co. of Skokie, Ill.

Four top executives of Stone & Webster Engineering Corp. have been elected vice presidents, it was announced by T. Cortlandt Williams, president.

The new vice presidents are **Harold F. Cleary** and **Donald N. McCord,** construction managers; **M. H. Cutler,** engineering manager; and **William R. Prang,** West Coast district manager.

Carrier Corp., air conditioning equipment manufacturer, has named:

V. C. Nelson

Walter A. Grant, director of engineering. He was already a vice president.

Walter H. Steitler, vice president and director of marketing.

Frank R. Littlefield, vice president and director of manufacturing. He was formerly in charge of the Manning, Maxwell & Moore plant in Watertown, Mass.

Victor C. Nelson, sales manager for cooling towers and sheet metal specialties manufactured by the Machinery & Systems Div.

C. A. Nolph to the newly created position of sales manager of military equipment in the Machinery & Systems Div. He was formerly sales manager of the Syracuse, N. Y. district.

Appointment of **Curtis H. Stout, Inc.,** as manufacturer's representative for The Pyle-National Co. in the South-Central area has been announced by Elliot M. Nesvig, vice president-marketing.

Nesvig also announced that **D. W. Jackson,** formerly of The Pyle-National district office at New Orleans, has been assigned to the company's district office at Houston as a sales representative.

Pyle-National has opened a new district sales office in Birmingham, Ala. with **Eugene P. Callahan** as manager.

Use Communications Center, page 37, for requesting more information about articles, advertised products, literature, etc.

Hugh Mullen has been appointed vice president in charge of operations for Buell Engineering Co., Inc., designer and manufacturer of air pollution and dust control equipment.

Hugh Mullen

He was formerly director of purchasing and administrative assistant to the president.

In his new assignment, Mullen will direct day-to-day operations of Buell.

Albert E. Ott has been named vice president and sales manager of Power Line Fan Co., industrial ventilation subsidiary of Chelsea Products, Inc., Plainfield, N. J.

Beckman Instruments, Inc. has named three new sales managers for its Scientific and Process Instruments Div.

George A. Green, as sales manager for the eastern region, will direct Atlantic Coast sales from the Beckman facility at Mountainside, N. J. He formerly served as a product line manager and as western region sales manager for process instruments.

Former eastern regional manager **Roy F. Brown** has been named sales manager for process instruments.

Jack A. Challacombe was named sales manager for the midwestern region operating from Chicago. He was formerly manager of the southeastern region office.

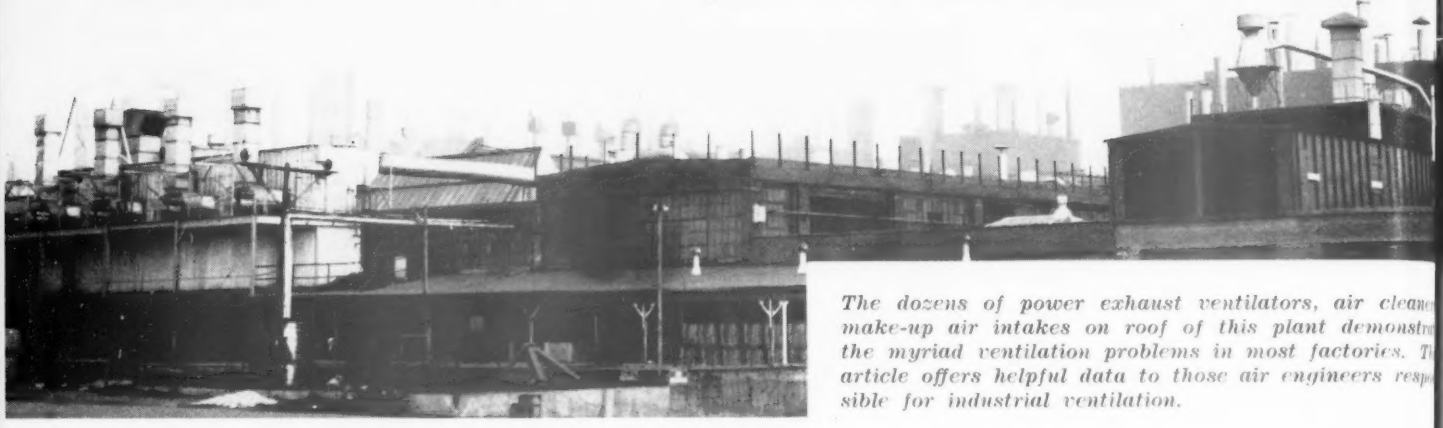
Berwyn Johnson has joined the research staff of Titus Mfg. Corp., Waterloo, Iowa, as research engineer in the Air Distribution Research and Development Laboratory.

B. Johnson

Johnson is a graduate of Iowa State University with a degree in Mechanical Engineering.

The Titus Air Distribution Research and Development Laboratory supplies engineering information and development of Titus products based on the fundamental needs for good air distribution.

PRIMER *on Factory Ventilation* PART I



The dozens of power exhaust ventilators, air cleaner make-up air intakes on roof of this plant demonstrate the myriad ventilation problems in most factories. This article offers helpful data to those air engineers responsible for industrial ventilation.

Now is the time to get ready for the heating season. Here is helpful data on which of the three basic make-up air systems to use, factors influencing sizing of make-up air units, types of equipment, temperature controls, filtering, air distribution, system numbering and cost factors involved.

MUCH HAS BEEN WRITTEN about factory ventilation over the past decade, yet new problems continually crop up to plague the air engineer in factories of all types. And at the recent 8th Annual Industrial Ventilation Conference, attended by hundreds of air engineers from nearly every state, the most popular course was plant make-up air and associated ventilation problems.

Although air is plentiful, and in its "raw" state, free, a lack of air to replace that exhausted from the plant atmosphere has been a greater cause of poor exhaust system performance than any other item.

Worse, the "starved air" condition is not always readily apparent. It's too easy to blame poor hood design, poor fan performance and to add or tap extra fan horsepower for higher fan rpm's. The adverse affects of added fan rpm on nearby exhaust systems is often ignored, further compounding the problem. Other evidences of insufficient make-up air are listed in detail in a previous article, devoted to the distribution of make-up air systems, on page 22 of the June issue of AIR ENGINEERING.

When provision for make-up air is not included in the first stages of planning industrial exhaust system installations, half the job is actually done . . . a practice which unfortunately is common in many plants even today.

Expansion of existing factory facilities may also cause added or changed make-up air requirements in areas adjacent to old quarters, as illustrated in Fig. 1. An entire department, once at the extreme end of this plant (a foundry), with lots of exposed wall and window area, is now almost fully buried within the remodelled plant.

The previously exposed wall areas were eliminated. Open doors and windows which provide a pleasant sweep of air over most of the room toward the power and gravity vents over the ovens are also almost completely eliminated. Power vents and burners over the ovens must now draw outside air through doors and windows in the west wall where core and casting cooling buildings are to be added.

Air velocities sufficient to cause uncomfortable drafts as far as 150 ft. inside the room are the result. Air flow in the gravity vents becomes reversed and the gas and heat rising from the ovens can no longer be exhausted but instead spreads to work areas in the room.

Balanced Ventilation

The obvious solution is a well planned installation of make-up air systems. It was estimated that approximately 600,000 cfm were to be exhausted from this area while only 160,000 cfm were being supplied by two general heating and supply systems. This meant a deficiency of 440,000 cfm in the area.

Installation of make-up air equipment was completed and supply and exhaust balanced (providing all units are in operation). It is also noted that with the installation of this make-up air equipment, many areas of contamination that might have been borderline, now are well within tolerable limits. This is especially true of fog or mist resulting from spray used to clean core boxes on the core machines. Due to the nature of the operation, suitable exhaust equipment here would have been prohibitive. In this area installation of the make-up air systems made further additional exhaust equipment unnecessary.

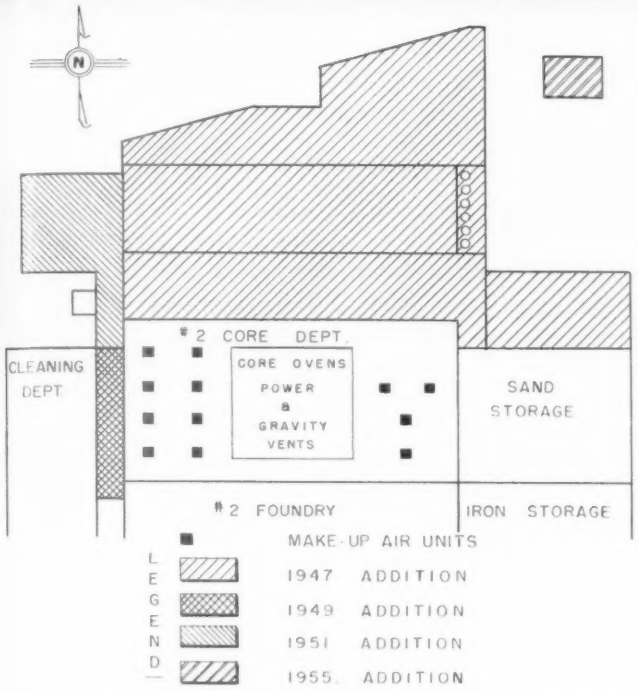


Fig. 1: *Extension of existing foundry facilities, as shown above, often changes make-up air requirements. Note how foundry is now buried within the remodelled plant.*

In some foundry conveyor basements too, the addition of make-up air systems often makes it possible to eliminate some exhaust equipment. Instead of extensive ductwork and hoods, many of the basements can be ventilated by general supply and exhaust systems of approximately equal capacity. Elimination of as much ductwork as possible allows additional room for maintenance operations. Maintenance and production personnel, alike, will always welcome this type of approach.

Another example and one which well illustrates the importance of make-up air is illustrated in Fig. 2. Here the roof of an entire room is raised from 24 ft. to 80 ft. above floor level. Power roof ventilators were installed as part of the building contract while air supply systems are to be added later as tower ovens and other production equipment are installed. This arrangement results in potentially a 360,000 cfm exhaust capacity against 120,000 cfm supply when the first production unit is placed in operation adjacent to the No. 1 Foundry Department.

Well meaning production personnel as well as construction people often feel that all roof ventilators should be operated to keep the area as clean and comfortable as possible. The result, however, will be that the power exhaust units haul air down the gravity stacks located over the No. 1 foundry department, through the overhead cooling conveyors picking up heat and smoke, through the door between the core room and foundry and then out through the core room high roof vents.

Conditions could become almost unbearable, with the immediate reaction, of course, of smoke and gas blowing into the core department from the foundry. Additional roof ventilator capacity would then be necessary in the core department. By systematic operation of the supply and exhaust equipment, however, it can be proved that a lack of supply air in the core department induces the flow of air from the foundry to make up the deficiency caused by the already excessive roof ventilator capacity.

Importance of Make-up Air

These examples are convincing evidence on a large scale that make-up air must be provided, and that it ranks in importance with exhaust systems in any program of effective industrial ventilation. Following is a description and discussion of make-up air systems now in use in many modern factories. While foundries are used as an example, the examples apply equally to most other types of industries.

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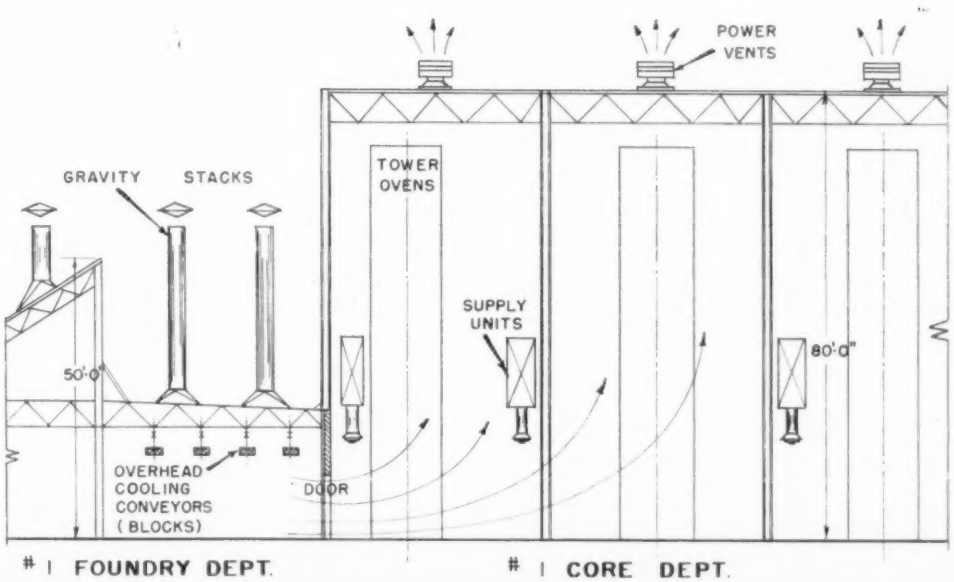

Fig. 2: *Here the roof of entire room is raised from 24 to 80 ft. Exhaust capacity is greater than supply, so smoke and gas blows into the core department.*

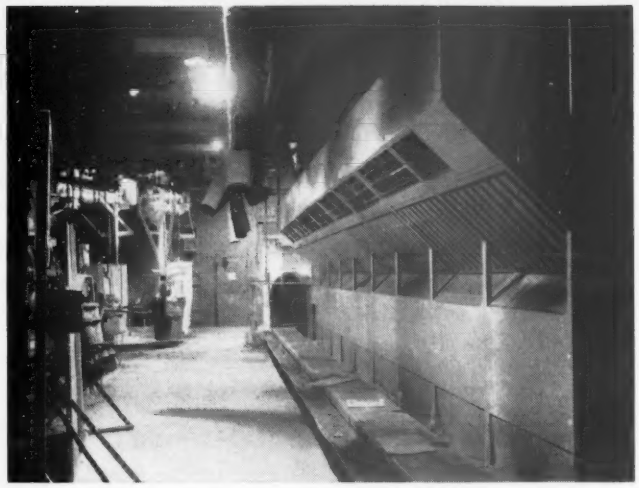

Fig. 3: *This compensating air system supplies air to an operation to replace air exhausted to control contamination. Depending on type of operation, air may or may not be filtered.*

(Continued from preceding page)

Types of Supply Systems

Supply or make-up air systems can usually be classified as follows:

1. Spot Cooling Systems
2. Compensating Air Systems
3. General Supply Systems

Spot cooling systems are supply systems providing cooling air to operators or equipment exposed to heat. This air may be filtered, washed, or cooled, but is usually not heated.

Compensating air systems supply air to an operation to replace air being exhausted from that operation to control contamination, as shown in Fig. 3. Depending on the type of operation, this air may or may not be filtered or tempered. In foundry operations such as pouring or mold cooling, this air is usually not conditioned in any way since personnel is not exposed.

General supply or make-up air systems are systems that blanket entire areas or buildings to replace air being exhausted and maintain the desired ventilation rate. These systems will normally contain heating equipment and, depending upon circumstances, may also include washing, filtering or other conditioning equipment.

Small vs. Large Make-up Air Systems

Factors which determine the size of a system are as numerous as the installations themselves and for that reason hard and fast rules cannot be made with respect to size. There are, however, very definite size factors to be weighed in each installation.

The following factors weigh in favor of the smaller, less extensive unit:

1. Ductwork and equipment are smaller, so space requirements for the ductwork and equipment are less.
2. Effects of a breakdown or shutdown are minimized, since the area involved would be smaller, the number of employees and operations involved fewer.
3. Small systems are more flexible during partial or reduced production schedules.
4. Smaller units can be controlled to more individual or operation requirements. This is especially advantageous in areas where a wide range of temperature conditions exist because of local or outside influences.
5. More and more manufacturers are offering package units of all types in the smaller size range, i.e., up to about 25,000 cfm capacity.
6. In case of serious difficulties requiring prompt action, smaller systems can be more readily installed to provide at least partial relief.

Disadvantages of Small Units

In contrast with these advantages are two very distinct disadvantages:

1. Multiple smaller units require a network of power, fuel, water, and steam lines.
2. Routine cleaning, inspection and maintenance as well as major repair increases almost in direct proportion to the number of units regardless of size. In other words, a 25,000 cfm system requires the same safety devices, controls, etc., as a 150,000 cfm installation. The smaller unit might, however, be shut down during production for check and adjustment, while the large system would necessarily have to be given routine inspections and adjustments on premium time to assure uninterrupted operation during production.

For the larger installations the pros and cons would normally be about the reverse of those listed for the less extensive units. In addition, two points which are in favor of the large system should not be overlooked.

1. One large intake can be more readily extended to a favorable area than numerous smaller ones.
2. Under similar circumstances the cost per cfm decreases as system size increases.

From the above then it is very obvious that no rule of thumb can be given from which system size can be readily set, although available space and economics could separately or together quickly dictate the small installation, all else to the contrary.

Methods of Heating Make-up Air

In order to assure a continuous supply of make-up air even during cold weather, provision should be made to temper or heat make-up air. If heating facilities are not included in the system, chances are the unit will be shut down during cold weather and closed conditions just when the supply air is most seriously needed.

For years steam has probably been the most popular of all heating systems in industrial plants. Exclusive of the generating plant, steam heating facili-

ties are relatively simple and easy to maintain and require no safety equipment. Package units are readily available in all capacities up to approximately 25,000 cfm (Fig. 4) suitable for recirculation or 100 percent outside air supply. Provided adequate steam supply and condensate facilities are readily available, the small steam unit can be quickly and economically installed when urgent relief is needed. However, if supply and return equipment and facilities must be provided as part of such an installation, cost may become excessive and other methods may have to be considered.

Steam heating facilities are often classed as high or low pressure, with 15 psi gauge as the dividing line. In industrial plants low pressure steam has been especially popular because piping layouts are simple and low pressure exhaust steam is often available from steam driven air compressors or turbines. The steam exhaust discharge-to-atmosphere valve is set to relieve at approximately 5 psi, which in turn provides up to 5 psi steam for heating purposes. From an economical standpoint, other methods of heating make-up air should not be used while exhaust steam is available.

Although considerable savings in supply pipe size can be realized with high pressure systems, layouts become more critical and additional specialties are necessary along with flash tanks and related equipment. Whether high pressure or low pressure steam is used, the following items should be remembered in designing a make-up air system utilizing steam for heating:

1. *Avoid long coils.* Under extreme heating conditions the end of the coil away from the steam supply connection may not properly heat the air, causing a temperature variation across the length of the coil. If such proportions are necessary for reasons of available space or otherwise, two coils should be used (Fig. 4) which are fed from opposite ends. Two coils will permit wider fin spacing on the tubes for easier cleaning and maintenance. If space allows, the two coils should be sufficiently separate to allow access between them for maintenance.

2. *Provide freeze-up protection.* Protection against freezing is very important when using steam heating coils. Various devices are available and in use, including strap-on and immersion devices which will shut down the system in case of condensate temperature drop. It should be remembered, however, that because of a lag in response, or trap failure, this equipment does not provide positive protection. For the same reason too, "non-freeze" coils may freeze up.

To facilitate maintenance inspection, cleaning and adjustment as well as repair, adequate access doors should be provided to permit thorough checking of

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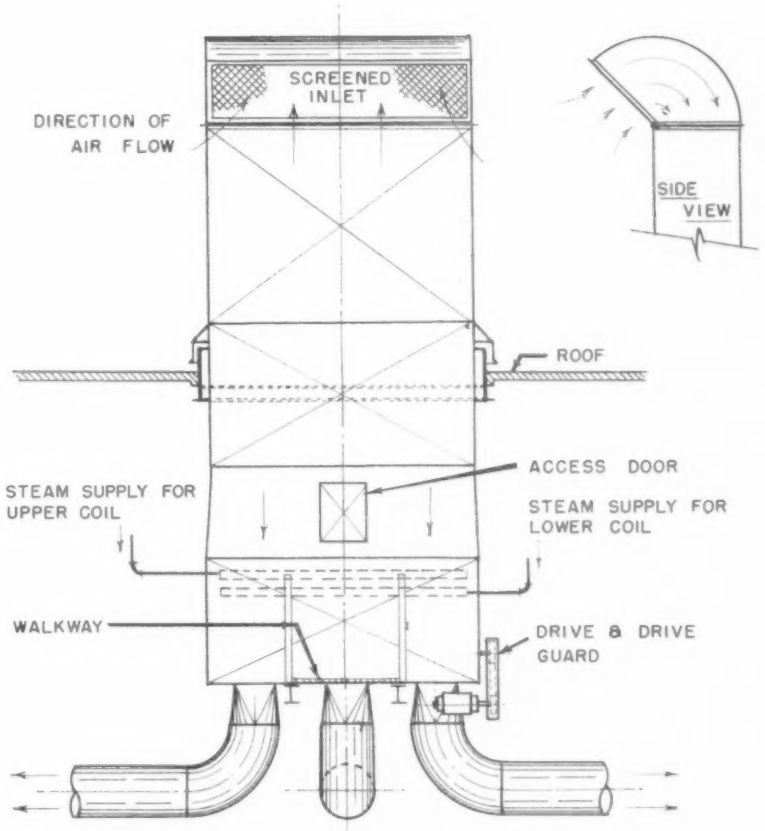

Fig. 4: *Right, typical make-up air unit available in capacities to about 25,000 cfm and suitable for recirculation or for 100 percent outside air. For economical installation, piping should be conveniently available.*

How to Filter Smog

by Gordon Wilson, *Chief Engineer*
Pacific Mutual Building, Los Angeles, Calif.

Fig. 1: *Employees of Pacific Mutual Building demonstrate charcoal filling machine for reactivating charcoal filters. Man in center holds jar for testing filter strength. Photos courtesy of Drayer-Hanson.*

Today's air conditioning system must do more than control temperature and humidity . . . it should filter out noxious gases, vapors and fumes present in outside air. Here's an interesting case history of a tough filtering job in one of the country's major smog areas.

In the Los Angeles area, back before the word "smog" was coined and the cough producing, tear jerking stuff had appeared, people in air conditioned factories and office buildings were content if the cooling system kept them comfortable from the summer season's frequent 85 F+ heat.

Today, when smog has induced outraged Los Angelinos to fork out some 3½ million dollars annually for air pollution control, when Los Angeles County boasts the world's most extensive, elaborate air pollution control equipment in the history of industry, when smog still creeps in on Los Angeles to the tune of sometimes severe physical discomfort, the phrase "air conditioned" has come to mean, at its best, "freedom from smog."

A case in point is our own modern office building, one of the largest in the West, the Pacific Mutual Building, located in downtown Los Angeles. We believe our year-'round air conditioning system to be the first to be designed specifically to eliminate smog 12 months of the year, as well as to maintain comfort conditions from a humidity and temperature standpoint.

The building uses a double-duct, high velocity air distribution system with chilled water as the cooling medium, supplied from two 600-ton capacity centrifugal refrigeration compressors.

For smog elimination, the consulting engineer selected a five section filter system, consisting of three layers of throwaway media, and two rows of activated charcoal. We, as well as our tenants, were completely sold on the activated charcoal idea from the very first. On our very worst September smog alert days, when even visibility was affected and the outside air was beginning to make people downright miserable, the air inside our building had absolutely no trace of smog . . . the air was clean, pure and invigorating.

The consulting engineer figured the charcoal filters for a life of one year, and he just about hit it on the nose. At year's end the charcoal needed reactivation. We began removal of the carbon filters for return to the manufacturer for reactivation on a week-end. By Monday we had not finished installing new carbon filters, when we had a bad smog alert. Complaints from building occupants began to come in, so we really had to work fast to get the second row of charcoal filters back in place.

Because of the large number of carbon filters used in our cooling system, we decided, on a cost basis, that it would pay us to remove the old activated charcoal from the tubes in the filter frame, rather than to send the entire unit, frame and all, back to the supplier for reactivating.

To fill the tubes with fresh activated charcoal, we made up a little homemade rig of our own design on the roof of our building, with a valve to control the flow of carbon into the filter tubes. We figure that one man can fill between 20 and 25 filter frames (20 in. x 20 in.) per hour. We ordered 2500 lbs of activated carbon and used almost exactly that amount.

To refill the tubes we put two men to removing tops and dumping old charcoal; two men to operate the filling rig and two men to replacing tops. We solved the spillage problem by doing the job on the

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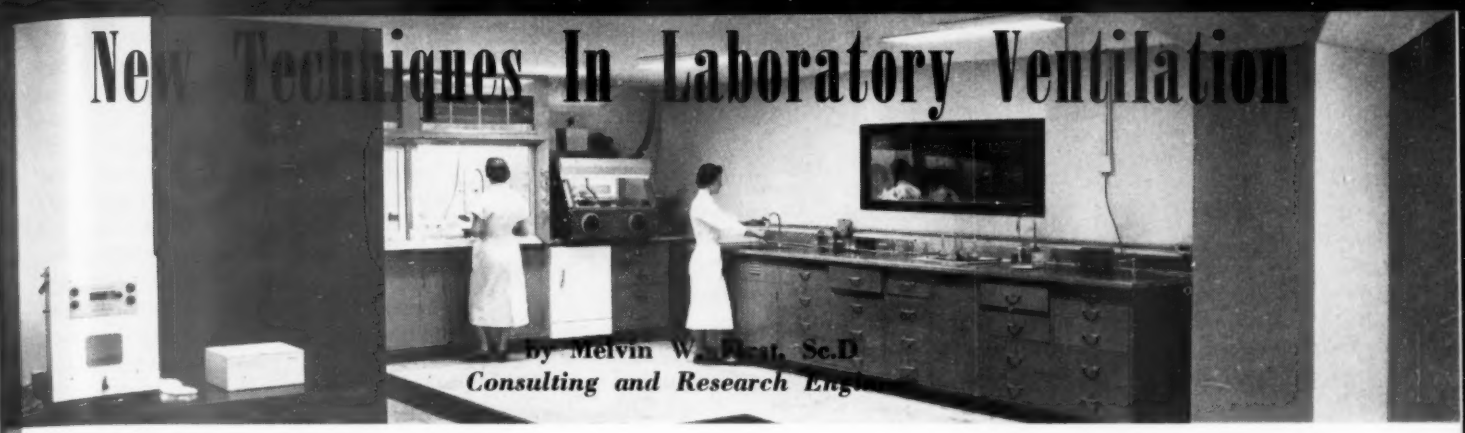
Fig. 2: *Charcoal filling machine, made of scrap sheet metal and angle iron, holds filter frames up to 20 in. by 20 in.*

New Techniques In Laboratory Ventilation



by Melvin W. [illegible], Sc.D
Consulting and Research Engineer

Textile Research Center, North Carolina State College, Raleigh, N. C. Courtesy of Kewaunee Mfg. Co.

Designing lab ventilation systems can be a tricky business. Air velocities are touchy, variables are many, hazards are very likely severe. Here are basic design methods for ventilating labs of all types.

SAFEGUARDING THE HEALTH and safety of laboratory workers requires effective control of dusts, fumes, vapors and gases generated in the course of their research investigations and test procedures. Beyond this, comfortable conditions are desirable because they promote efficiency. Therefore, control of effective temperature, which includes temperature, humidity and motion of air about the worker, is an important consideration.

General Laboratory Ventilation

Many educational and industrial laboratories perform only physical test procedures and no special provisions are required for elimination of toxic, corrosive, explosive or odorous chemicals. For these laboratories, normal heating and ventilating standards that apply to offices and public rooms are generally adequate. Ventilation rates should be based upon minimum outdoor air requirements to remove objectionable body odors (ranging in value from 7 to 25 cu. ft. per minute per person) or upon dilution of tobacco smoke odors (which may require 30-50 cu. ft. of outside air per minute per cigarette smoker).[1] For operational economy, any fraction of the heated air in winter, or cooled air in summer, introduced into the laboratory for temperature control purposes which is in excess of these ventilation requirements, may be recirculated.

Control of Contamination by Dilution

Ventilation requirements for laboratories having limited, or perhaps infrequent, use for such materials as volatile solvents of low toxicity and odor intensity, may be based on the amount of outside air required to dilute the contaminating material to a satisfactory level from the standpoint of: (a) fire and explosion (b) toxicity and (c) odor. Control systems employing the dilution method are often indicated when the contamination originates at a few points scattered throughout a large area. Air may not be recirculated and all exhausted air must be replaced by fresh outside air which is heated in winter, and, for a completely air conditioned space, cooled in summer. In addition, particularly in industrial or commercial areas, air filtration may be required yearround to remove dirt and other particulate contaminants and occasionally the removal of gaseous contaminants by absorption or adsorption becomes necessary.

The first step in the design of a ventilation system employing the dilution method is to determine as exactly as possible the nature and extent of the contaminating load. This information will often be available from purchase records which reflect consumption of commonly-used agents. Designs based

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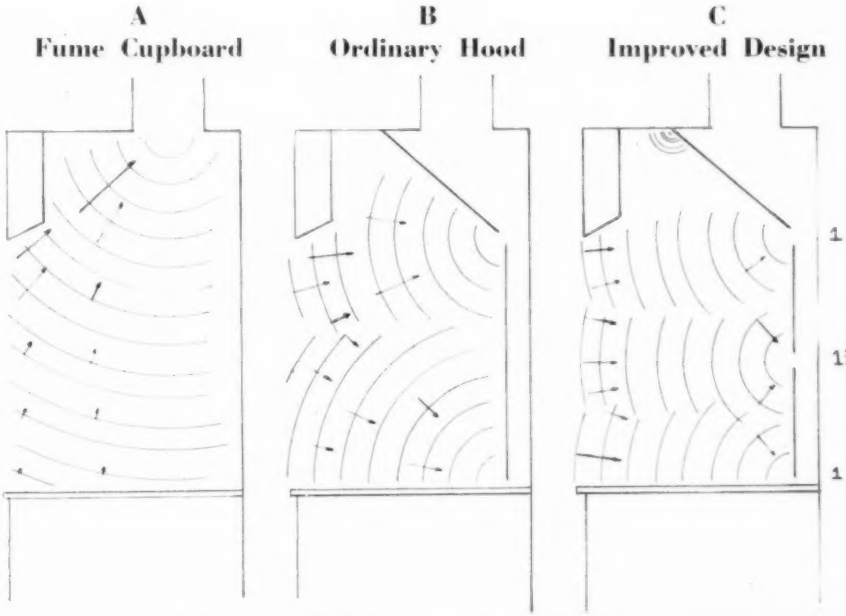

Fig. 1: *Air flow patterns of laboratory hoods.*

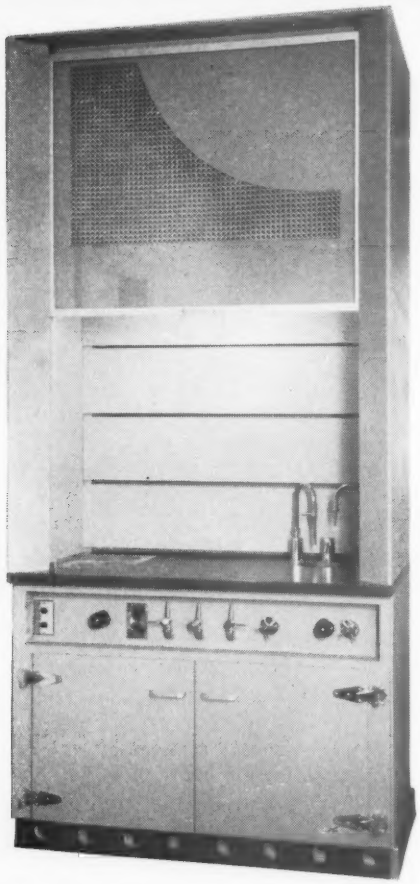

Fig. 2: *Constant face velocity laboratory hood with multiple exhaust slots. Reproduced with permission from A. B. Stanley Co., Newton, Mass.*

(Continued from preceding page)

on rule-of-thumb methods such as "number of air changes per hour" are inexact for this purpose and usually result in unsuccessful operation or excessive installation and operating costs.

Allowable concentrations for most commonly-encountered gases and vapors have been established by the American Conference of Governmental Hygienists (ACGIH)[2] so that it is rarely necessary to completely remove contaminating agents from the atmosphere. Utilizing information on maximum allowable concentration (MAC) and addition rate of the contaminant to the laboratory atmosphere, the volume of dilution air required to maintain an acceptable level may be calculated from the following equation:

$$Q = \frac{V \times 10^6}{(MAC) - (SAC)}$$

where:

Q = the quantity of air to be circulated (cubic feet per minute).

V = rate of generation of contaminant (cu. ft. of vapor per minute).

MAC = maximum allowable concentration (parts per million by volume).

SAC = concentration of contaminant in supply air (parts per million by volume).

Since air recirculation is inadvisable, the concentration in the supply air will generally be zero and the circulation rate (Q) becomes simply: $\frac{V \times 10^6}{(MAC)}$. The rate of generation of the contaminating vapor in cubic feet per minute (V) may be calculated from the weight of liquid evaporated into the space per unit time by applying the principle that a pound-mol of a liquid occupies approximately 385 cu. ft. when converted to vapor at ambient temperature. For example, the molecular weight of acetone is 58. When completely evaporated, the pure vapors from 58 pounds of acetone (8.8 gallons) occupy a volume of 385 cu. ft.

Control of Contamination by Exhaust Hoods

Information on the maximum allowable concentration of many dusts, fumes and mists is also available from ACGIH but the dilution method is ordinarily inapplicable for treating particulate contaminating agents, since allowable air movement in laboratory spaces is lower than the velocity required to capture such particles. Therefore, exhausting at the source is the recommended method for controlling particulate contaminants. Local exhaust systems are also indicated when contamination originates in concentrated areas and when the toxicity, odor or corrosiveness of the contaminants makes removal by simple dilution impractical. The laboratory hood is commonly and successfully used for eliminating these hazards and is one of the most important of all laboratory facilities.

The purpose of the laboratory hood is to confine air contamination within the hood proper so that the contaminant concentration in the worker's breathing zone is less than the maximum allowable concentration. Fig. 1 shows three common laboratory hood designs. The type known as a "fume cupboard" (diagram A) possesses high velocities at the top of the hood face and low, often negligible, velocities at the bottom. Good hood operation requires uniform and adequate velocities perpendicular to the hood face since contamination may originate near the floor as well as in other locations of the hood. Acceptable flow patterns can be achieved in ordinary hoods by utilizing baffles and exhaust slots as shown in diagram B of Fig. 1. Each slot establishes its own constant velocity contours which tend to merge into a uniform air flow velocity at the hood face. Further improvements in velocity profile may be obtained by employing a third slot in the middle of the back baffle, as shown in diagram C of Fig. 1.

Diagram C indicates that top, middle and bottom slots are proportioned on a ratio of 1:1¾:1. In practice, bottom and top slots are often made somewhat larger to overcome velocity drag at top and bottom hood surfaces. In addition, a larger top slot assists in the removal of evaporated materials while a larger bottom slot tends to overcome the handicap created by obstructions in the form of reagent bottles and equipment.

Good design requires slot velocities ranging from 700 to 1400 fpm. Hood plenum and slots are proportioned so that a major portion of the resistance to air flow occurs in the slot openings; in other words, a uniform negative pressure is created throughout the plenum chamber. This is accomplished by maintaining the slot area at less than ⅔ of the plenum cross-sectional area. For these conditions, air velocity through each slot opening will be equal and the amount of air exhausted by each slot will be proportional to its area. To achieve absolutely uniform velocity at the hood face with minimum distance between contaminant sources and hood exit, the back baffle should be uniformly perforated with small holes. However, if the holes are made small enough to provide proper air balance, they rapidly clog with dirt and require frequent cleaning. Fig. 2 illustrates a practical compromise; multiple exhaust slots in the rear hood baffle.

Dispersion from Laboratory Hoods

It is necessary to consider the manner in which materials become dispersed, in order to determine

what face velocities will be required to prevent escape of contamination from laboratory hoods.[3]

Respirable dust particles and mists; i.e. those less than 10 microns in size, flow with the air in which they are suspended and, therefore, hood face velocities which prevent escape of air from within hoods are sufficient to control all particulate contamination. These velocities may be less than 50 fpm if the hood design and location are ideal. When the nature of operations within a hood causes high air velocities to be directed outward (as may be the case when using compressed air or gases or when operating high speed machines such as grinding wheels) control velocities necessarily must be higher, although they need not match the initial velocity with which the particles are projected outward, since the distance small particles travel when projected into still air at high velocity is negligible. For example, a 10 micron particle having an initial velocity of 10,000 fpm travels only 1.6 in. in still air before its velocity decreases to zero.

For vapors and gases, the forces of molecular diffusion determine the rate of dispersion and this, in turn, establishes a minimum air velocity required to prevent escape from the hood of amounts exceeding the maximum permissible levels.

The amount tending to escape from an enclosure by diffusion per unit time is dependent upon: (1) the difference in concentration of the contaminant inside and outside the hood (2) the diffusion constant, a physical property of the material, and (3) the distance vapors must travel to leave the hood enclosure. Experience demonstrates that with the exception of highly toxic radioisotopes, relatively low hood velocities (ie. less than 50 fpm) are adequate to overcome the forces of gas and vapor diffusion.

Air disturbances originating outside the hood are a third factor causing dispersion of contaminants from hoods. These currents sweep past the open hood face and induce or aspirate flow out of the hood into the laboratory. High velocity room air currents originate from open windows and doors, laboratory traffic, excessive ventilation supply-air currents, high speed machinery, etc. For example, a person walking at a normal pace travels at a speed of 3 mph, equivalent to 340 fpm; winds entering open windows may vary from 5 to 15 mph (570-1700 fpm) and doors present a similar picture.

Thus, it is easy to understand why hoods located beside open windows, doors and major traffic lanes are likely to be ineffective. Hoods located in dead-end areas or ells are most suitable so far as location is concerned and resemble a hood-within-a-hood. Wall locations with no air interferences at the hood extremities and corner locations are also satisfactory. (When considering hood location it is important to consider means of escape in case of fire.) In good locations, hood face velocities from 50 to 100 fpm are usually sufficient to prevent losses into the room by outside air currents. Since these velocities are higher than are needed to prevent losses by particle projection or by gas and vapor diffusion, room air convection currents are the sole factor that need be considered in determining adequate hood face velocities.

Radioisotope Hoods

The high degree of toxicity of radioisotopes places additional demands on laboratory hoods. These requirements may be summarized as follows:[4]

1. Air velocity at the hood face should be: (a) uniform (b) perpendicular to the plane of the face of the hood and (c) between 100 and 200 fpm.
2. All facility controls should be located outside the hood. (See Fig. 2.)
3. The bench top should be capable of supporting a load of at least 500 lbs. per sq. ft. to accommodate lead shielding materials.
4. The bench top should contain a removable tray with rounded edges to retain spills. This tray should have a drain leading to the hood drain system to facilitate washing.
5. Inside surfaces of the hood should be acid-resistant and easy to decontaminate. When activity levels exceed microcurie amounts, use of strippable coatings on inside surfaces of hoods is desirable.
6. Only vapor-proof electric fixtures should be used.
7. Efficient filters of the AEC absolute-type should be installed at the rear of the hoods to filter the exhaust air when highly contaminating materials are used.

Constant Velocity Hood Openings

Constant velocity through the open hood face, regardless of sash position, may be obtained by means of numerous techniques which proportion the amount of air passing through the hood face, according to the actual hood opening. A loss of valuable materials, particularly fine powders, can occur in the high velocity air stream created by low sash positions when using conventional types of hoods.

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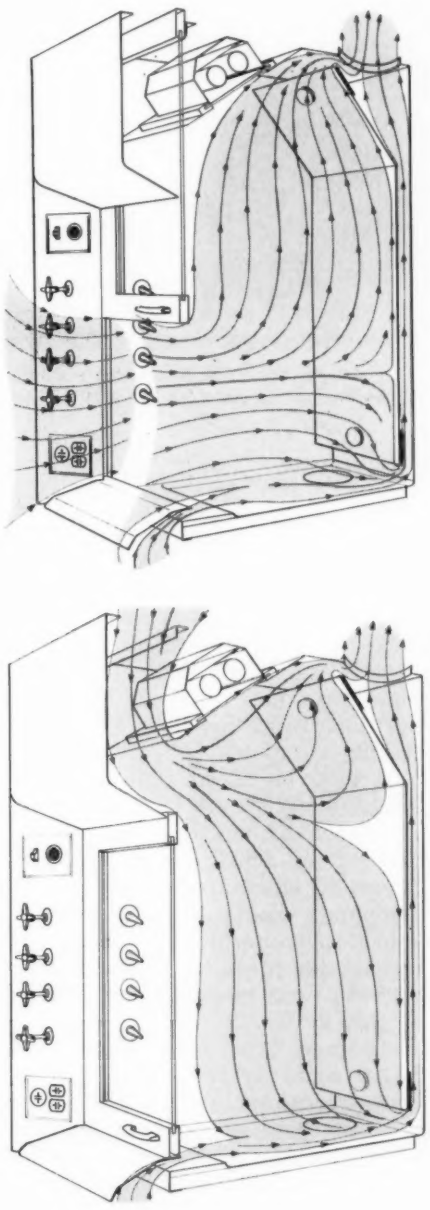

Fig. 3: *Constant face velocity laboratory hood with air-foil entry. Reproduced with permission from Kewaunee Mfg. Co., Adrian, Mich. Upper drawing shows air flow with sash up. Lower drawing shows air flow with sash down.*

Fig. 4: *Pressurized laboratory hood showing supplementary air supply grille above and inside hood face opening. Courtesy Mr. R. I. Chamberlin.*

(Continued from preceding page)

In one design of constant velocity hood, shown in Fig. 3, all the exhaust air passes through the hood proper, but the relative amounts admitted through the open hood face and through a by-pass opening located above the hood face depend upon the sash position, which acts as a proportioning damper.

It may be noted that all hood facility controls are located outside the hood. An added feature is the use of "air foils" at the hood entrance to eliminate vortices which commonly occur at the square edges of conventional hoods. A modest improvement in hood performance has been detected by use of this device.[5]

Another type of constant velocity hood is shown in Fig. 2. Here, excess air by-passes the hood proper and passes directly into the hood plenum. The hood sash, as before, acts as a sliding damper opening the by-pass when the sash is down and closing it when the sash is up. The by-pass opening to the hood exhaust plenum is specially shaped in accordance with the known behavior of air flowing through an orifice opening to correctly proportion the air between hood face and by-pass opening.[3]

Make-Up Air

Even correctly designed hoods become ineffective during periods when they are closed off from a source of make-up air. In addition to inadequate hood face velocities, poor performance from this cause is characterized by discomfort from infiltration of untempered air through cracks and openings in the building, especially at windows and doors, and reverse air flow through low pressure general ventilation systems. These conditions should be anticipated and provisions made for an adequate air supply. Conditioning make-up air for laboratory hoods does not necessarily increase heating or cooling requirements, since untempered air infiltrating from the outside must be heated or cooled in some manner if comfortable temperatures are to be maintained in the laboratory.

The quantity of make-up air supplied to a laboratory may be somewhat larger than the exhaust volume in order to maintain the entire laboratory space under slight positive pressure. By this means, airborne contamination from adjacent laboratories may be prevented. Other situations require maintaining a laboratory under slight negative pressure relative to its surroundings. This may be accomplished by reducing the make-up air supply to 80-90 percent of the exhaust volume. The remaining air will be supplied largely through openings in doors and partitions. Isotope laboratories in which highly radio-active, highly toxic materials are handled are often maintained under slight negative pressure relative to surrounding areas so as to minimize spread of contamination while analytical laboratories dealing with trace analyses are best maintained under a slight positive pressure.

In recent years there has been a rapidly growing tendency to provide year-round air conditioning for laboratories. Usually this includes heating air in winter, cooling it during warm weather and filtering it for dust removal at all seasons. When testing is performed under strict ASTM standards, it becomes necessary to maintain the laboratory at a temperature of 73.4 F and 50 percent relative humidity on a year-round basis. However, most research and development laboratories are adequately served by adhering to the usual comfort standards of 70-74 F in winter and 75-78 F in summer with little or no control of relative humidity. (Occasionally, temperatures and humidity conditions widely divergent from these may be required for highly specialized research purposes.) Regardless of the exact conditions that must be maintained, providing a special environment is costly and economy should be exercised in the amount of air discharged from the laboratory.

Reducing Make-Up Air Requirements

Since exhaust air may not be recirculated and hood requirements generally exceed the amount of ventilation air required for heating and cooling purposes, a great deal of interest has developed in laboratory hoods which reduce the amount of conditioned air discharged to the outside. This has led to the development of so-called "pressurized," "auxiliary-air" or "supply air" hoods.

As originally conceived, one such hood was equipped with high velocity jets of 1000-2000 fpm which blanketed the entire open face area

and induced a positive flow of secondary air into the hood face from the room. Jet air and secondary air were exhausted from the hood in the usual manner. It was theorized that the high velocity jet would not be disrupted by room air currents generated by traffic, open windows, etc. and hence the quantity of air exhausted from the work room (as distinguished from the jet air supplied from another source) would be but a small fraction of the total air exhausted from the hood.

Economies achievable by this mode of operation in completely air conditioned laboratories are obvious. However, experience indicates that a high velocity jet stream produces turbulence eddys which sweep fumes out of the hood when the jet strikes apparatus, sides, floor and back of the hood.

A similar situation develops when an operator puts his arms into the hood to work with the apparatus. To overcome these objections, the supply-air jet has been reduced to a velocity of approximately 200 fpm in recent models of this type of fume hood, Fig. 4.

The change appears to be successful insofar as eliminating jet turbulence is concerned but the low jet velocities have lost their power to induce air flow into the hood and are non-functional. In fact, these hoods were observed to operate just as satisfactorily when the supply-air system was turned off and it is clear that effective control can only be obtained by maintaining adequate air flow into the hood face.

Under these circumstances, positive pressure hoods (1) create an unnecessary need for supply air blowers, air filters, air heaters and additional ductwork (2) increase the size and/or speed of exhaust blowers and (3) greatly increase the overall noise level in the laboratory.

Recent development efforts have been directed toward the utilization of low-velocity, auxiliary air supplies located around the periphery, but outside, the face of the laboratory hood. In such an arrangement turbulence - forming air jets are avoided and all air enters through the hood face. However, acceptance by chemists who must, of necessity, be enveloped in an untempered flow of air while working in front of this hood is far from assured.

Horizontal Sliding Sash

Economies in the utilization of conditioned air for exhaust hoods can be achieved most satisfactorily by maintaining required face velocities but restricting the open area of the hood face. The use of transparent, horizontal sliding sash (safety glass or Plexiglass) for laboratory hoods, illustrated in Fig. 5, has been successful in many cases. Horizontal sliding sash have an advantage over vertical sliding sash because the full height of the hood opening is always available in those areas that are open and a satisfactory working height remains even when the hood face area has been diminished by a half or more. In addition, a horizontal sliding sash can be an important safety device since it makes it possible to interpose a transparent shield between experiment and experimenter and yet permits ease of manipulation by reaching the hands around the back of each side of the panel. In many instances, the use of one or two horizontal sliding panels has made it possible to reduce over-all air requirements by one half, an important saving in air conditioned buildings.

Exhaust Hood Piping

Individual exhaust blowers for each laboratory hood permit maximum flexibility, but there is no real objection to connecting several hoods into a single system, provided positive means are available to prevent most of the hoods from being closed off simultaneously from the exhaust system by lowering the sash, since this produces excessive face velocities in the remaining hoods and may extinguish burners or disperse finely divided materials. Two-inch rubber blocks at the bottom of the vertical sash guides, or horizontal sash that do not completely close the hood face, can be used to eliminate this undesirable situation.

The use of a common discharge stack for two or more hood blowers, often to reduce the number of openings through the roof and to preserve architectural design, is unsatisfactory because of back flow of contaminated air through unused branches. Backflow dampers are unreliable in laboratory hood systems because of frequent use of a wide variety of corrosive chemicals and plastic solvents and are not recommended. When the use of a common discharge stack cannot be avoided, all blowers on the same system must be electrically interconnected so that all operate simultaneously ▲▲

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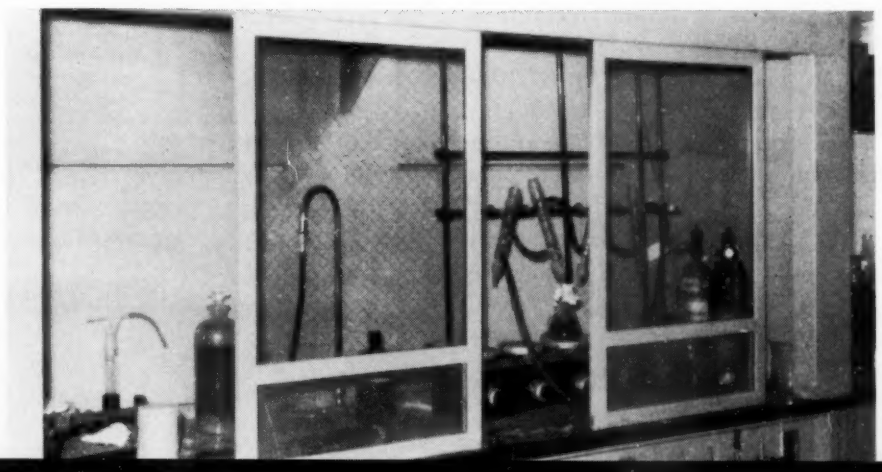


Fig. 5: *Laboratory hood with horizontal sliding sash. Courtesy Mr. F. J. Viles, Jr.*

Tips on Fan Selection for High Temperatures

By R. H. Lynch
Application Engineer
General Blower Co.

PART II

Part 1 described types of heat fans and how to care for them. Here's how to apply data from manufacturer's selection tables.

THE APPLICATION OF ELEVATED TEMPERATURE FANS is simple if a few basic rules are memorized. Since we deal with air (a fluid in a gaseous state) the density of the air will determine our static pressure and brake horsepower requirements at the selected point of operation.

The cubic feet per minute (cfm) and the velocity at which the air moved through the ductwork will not vary (as related to the temperature).

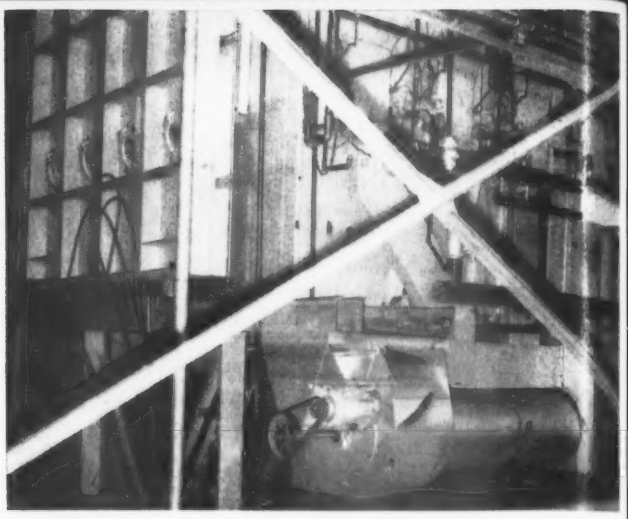
There are usually two methods of calculating requirements for high temperature fans:

1. From a known cfm
2. From the pounds of air per minute at "X" temperature at "Z" static pressure.

If cfm is known the fan can be selected directly from the manufacturer's fan capacity tables. (Dry air at 70 F, at sea level – 29.92 in. barometric pressure at standard density of .07495 lbs. per cu. ft.)

If pounds of air per minute, or per hour, are known, it is a simple calculation to convert to cfm required.

As shown in Table A, 187.3 lbs. of air at standard density would require 2,500 cfm. In the example, the density of air at 600 F is approximately 50 percent of that at 70 F, thus 0.075 (density standard air) divided by 0.03746 (density at 600 F) results in 5,000 cfm of standard air being required (at 70 F) when selecting the requirement based on weight of air.



Elevated temperature fan installed on aluminum heat treating furnace. Sunbeam Equipment Corp., Meadville, Pa.

Table B indicates the properties of air at various temperatures from –50 through 1,800 degrees F. This table will prove of considerable assistance as it covers low temperatures as well as elevated temperatures.

For many blower applications, the system will start with a requirement for pounds of air per minute. During the process, the air may pass through a heating device, such as a heat exchanger, etc., resulting in a change in density of the air. Since blowers are usually direct-connected the pressure will vary as the density and may require a much larger blower.

Table A
Example for Heat Fan Selection

REQUIREMENT: Heat Fan to handle 187.3 lbs. of air per minute at 600 degrees F., at 1" Static Pressure.

(Since Fan Capacity tables are based on standard 70F air at 29.92 barometric pressure at 0.075 lbs. per cubic ft. 50% relative humidity — Heat Fan selection must be made on the basis of standard 70 deg F. air.)

1. $\frac{187.3 \text{ lbs. air}}{0.075 \text{ lbs. per cubic ft.}} = 2500 \text{ C.F.M. (70F)}$

   Density of air at 600F being 0.03746 (see "Properties of air" Chart for additional density information.) Convert to C.F.M. at 600F

   $\frac{187.3 \text{ lbs. air}}{0.03746 \text{ lbs. per cubic ft at 600F}} = 5000 \text{ CFM or}$

   $\frac{2500 \text{ CFM} \times 0.075 \text{ (std. air)}}{0.03746 \text{ (600F)}} = 5000 \text{ CFM.}$

2. Pressure of 1" SP at 600F. Refer to Column "B" Heat Fan Factor Chart. At 600F, multiplier is 2.0. Therefore, 1" SP (at 600F) times 2.0 equals 2" SP at 70F.

3. Fan at deliver 5000 CFM at 2" SP at 70F. Reference to Fan Capacity table indicates fan would require 5.6 Bhp (70 F) to deliver these conditions. Once again referring to Heat Fan Factor Chart — Column "A" indicates multiplier is .5 at 600F:

   5.6 Bhp at 70 F × .5 (600 F) = 2.8 Bhp at 600F

NOTE: Always select sufficiently sized power device (motor, etc.) based on COLD starting Bhp, unless proper control devices safeguard against possibility of overloading.

RECAPITULATION To handle 187.3 lbs. of air per minute at 600F at 1" S.P. select fan for:

5000 CFM — 2" S.P. — 70F — 5.6 Bhp
5000 CFM — 1" S.P. — 600F — 2.8 Bhp

Table B

Properties Of Air

(Barometric Pressure — 29.921")

Temp. Degrees F	Density Pounds per Cubic Foot
-50	0.09690
-45	0.09573
-40	0.09459
-35	0.09348
-30	0.09239
-25	0.09133
-20	0.09029
-15	0.08927
-10	0.08828
- 5	0.08731
zero	0.08636
+ 5	0.08544
10	0.08453
15	0.08363
20	0.08276
25	0.08190
30	0.08107
35	0.08025
40	0.07945
45	0.07866
50	0.07788
55	0.07713
60	0.07640
65	0.07567
70	0.07495
75	0.07424
80	0.07356
85	0.07289
90	0.07222
95	0.07157
100	0.07093
105	0.07030
110	0.06968
115	0.06908
120	0.06848
125	0.06790
130	0.06732
135	0.06675
140	0.06620
145	0.06565
150	0.06510
160	0.06406
170	0.06304
180	0.06205
190	0.06110
200	0.06018
220	0.05840
240	0.05673
260	0.05516
280	0.05367
300	0.05225
350	0.04903
400	0.04618
450	0.04364
500	0.04138
550	0.03932
600	0.03746
700	0.03423
800	0.03151
900	0.02920
1000	0.02720
1100	0.02542
1200	0.02393
1300	0.02258
1400	0.02138
1500	0.02025
1600	0.01920
1700	0.01838
1800	0.01755

All tables in this article copyrighted by General Blower Co., Morton Grove, Ill.

if the density change is not taken into account during calculations.

A good rule to remember, therefore, is that cfm is a constant, once selected either directly from the fan manufacturer's capacity tables, or calculated based on weight of air. Referring again to the example, we will require 5,000 cfm at 70 F, or at 600 F.

In the selection of a fan unit to deliver 5,000 cfm at 70 F from the manufacturer's capacity tables, it then becomes necessary to find what the fan static pressure and brake horsepower requirements will be at elevated temperature.

Table C is a rapid method to use a multiplier to correct both bhp and sp to elevated conditions.

The factors in Column "A" are computed as follows:

$$\frac{\text{460 F absolute plus 70 F}}{\text{460 F absolute plus 600 F}} = .5$$

Factors in Column "B" are reciprocal numbers, inversely of the same formula:

$$\frac{\text{460 F absolute plus 600 F}}{\text{460 F absolute plus 70 F}} = 2.0$$

Six hundred degrees Fahrenheit has been chosen as example as at 600 F the inverse formula works out to be either .5 or 2.0. This is a good point to remember in your calculations inasmuch as it often gives a "spot-check" of your results and figures.

To Apply Table C

In the example, we have selected a fan to deliver 5,000 cfm at 2 in. sp at 70 F. At this point, in the manufacturer's capacity table, we find the selected fan operates to deliver 5,000 cfm at 2 in. sp at 70 F:

5,000 cfm – 2 in. sp – 70 F – 1,000 rpm – 5.6 bhp.

Constants

Five thousand cfm and 1,000 rpm will remain constant. (Temperature, bhp and static pressure will now vary due to the density of the air handled.) Refer to Table C:

At 600 F, our multiplier is .5. Consequently, we will multiply sp and bhp by this figure to determine our operating conditions at the elevated temperature 600 F:

2 in. sp × .5 gives 1 in. sp at 600 F.

5.6 bhp × .5 gives 2.8 bhp at 600 F.

Recapitulation

The fan unit as selected will operate as follows during elevated temperature operation:

5,000 cfm – 2″ sp – 70 F – 1,000 rpm – 5.6 bhp

5,000 cfm – 1″ sp – 600 F – 1,000 rpm – 2.8 bhp

5,000 cfm – .54″ sp – 1500 F – 1,000 rpm – 1.512 bhp

As a further example operating conditions at 1500 F (same fan) have been indicated.

(Please turn to page 39)

Table C

Heat Fan Factor Chart

A	Degrees F.	B
1.15	0	.886
1.04	50	.96
1.0	70	1.0
.952	100	1.05
.905	125	1.10
.865	150	1.15
.835	175	1.2
.804	200	1.24
.773	225	1.29
.745	250	1.34
.721	275	1.39
.698	300	1.43
.675	325	1.48
.655	350	1.53
.635	375	1.57
.617	400	1.62
.598	425	1.67
.582	450	1.73
.567	475	1.76
.552	500	1.81
.538	525	1.85
.525	550	1.91
.512	575	1.95
.5	600	2.00
.489	625	2.05
.477	650	2.09
.466	675	2.14
.457	700	2.19
.448	725	2.23
.437	750	2.28
.428	775	2.33
.421	800	2.37
.413	825	2.42
.404	850	2.47
.396	875	2.52
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.369	975	2.7
.363	1000	2.75
.357	1025	2.8
.351	1050	2.85
.345	1075	2.89
.339	1100	2.94
.335	1125	2.99
.329	1150	3.04
.324	1175	3.08
.319	1200	3.13
.315	1225	3.17
.31	1250	3.21
.305	1275	3.27
.301	1300	3.32
.397	1325	3.37
.292	1350	3.42
.289	1375	3.46
.285	1400	3.51
.281	1425	3.56
.277	1450	3.60
.274	1475	3.65
.27	1500	3.7
.267	1525	3.74
.262	1550	3.81
.258	1575	3.83
.256	1600	3.89
.254	1625	3.94
.251	1650	3.97
.250	1675	4.00
.245	1700	4.07
.243	1725	4.10
.242	1750	4.17
.240	1775	4.15
.234	1800	4.26

METEOROLOGY...

A Modern Tool of Management PART II

Here are meteorological factors to consider in selecting a new plant site or in controlling emissions from an existing plant. Topography, wind direction, and velocity are important factors.

by E. Wendell Hewson
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and
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PART I OF THIS ARTICLE in the July issue of AIR ENGINEERING described some of the factors the air engineer as a "do-it-yourself" meteorologist should consider in working with the atmosphere. Other factors, particularly as they pertain to plant location, are outlined in this concluding instalment.

Topography and Air Pollution

Any complete discussion of the meteorological aspects of air pollution must inevitably include some remarks about topography. Certain combinations of local terrain and bodies of water produce special micrometeorological effects upon the primary meteorological variables.

We usually think of topographical influences as being unfavorable but of course there are also favorable influences; the chronic problem at Los Angeles would certainly be lessened if the city were not situated at the bottom of a bowl. The disaster at Donora was made possible by the stagnation of air in a valley.

The Trail (4) problem illustrated another aspect of the influence of topography upon the primary meteorological variables. If the source of pollution lies in a valley or if there is a body of water nearby the meteorological influences upon air pollution become complex. Very careful studies will then be required in order to understand the characteristic circulations which determine the ventilation rate and the true nature of the local air pollution problem.

Even for the experienced meteorologist it is by no means possible to diagnose fully all the pertinent

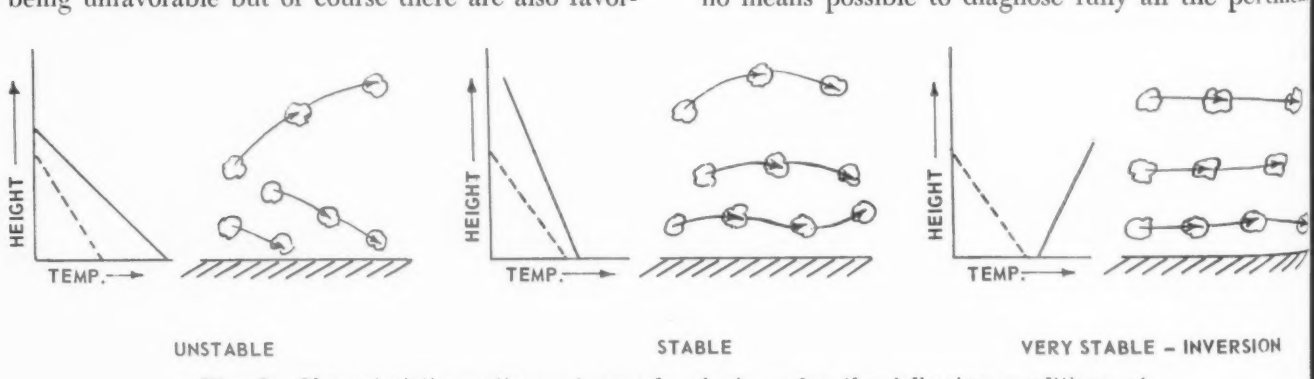

Fig. 3: *Characteristic motions of parcels of air under the following conditions of atmospheric stability: unstable, stable, and very stable—inversion. Broken lines on the graphs represent the critical vertical temperature distribution, 5½ F per 1,000 ft., which is the limiting value between unstable and stable meteorological conditions.*

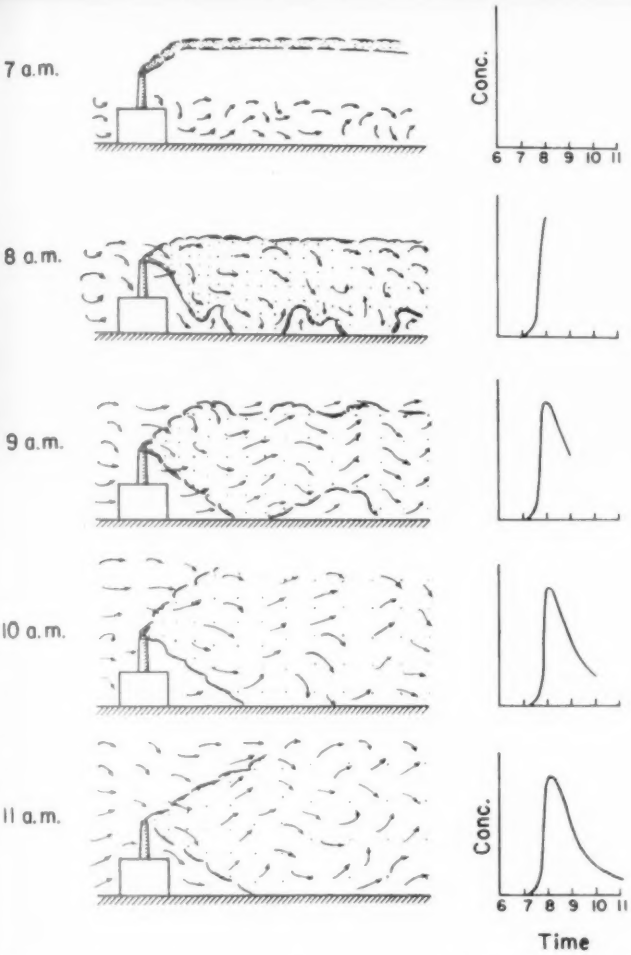

Fig. 4: *Above, these drawings show the physical processes by which the break-up of an early morning inversion leads to valley surface fumigation.*

topographical factors simply by inspection of a site. For example, some of the local effects that have been uncovered at the Enrico Fermi Reactor site at the west end of Lake Erie were not anticipated, although a special meteorological study was undertaken because there was every reason to expect special lake influences upon dispersion to exist in some form (1). A few general rules are emerging, however, as more and more on-the-spot studies of air pollution meteorology are undertaken.

Air Pollution In a Valley

One of the most interesting and most common topographical influences upon air pollution occurs in open-ended valleys such as river valleys. During the night, inversions tend to develop and a gentle, nearly laminar river of air flows down the valley. Under such circumstances the effluent from a tall stack may meander along overhead with very little vertical diffusion (2) and limited horizontal diffusion because of the physical barrier presented by the valley sides, as illustrated in Fig. 3.

By dawn the valley for many miles will feature a recognizable plume of smoke a few hundred feet above ground. Soon after dawn, on a clear summer morning, the rising sun begins to warm the surface layers, causing an unstable layer of air to develop near the valley floor and to grow upward. This unstable layer, having the characteristic overturning of thermal turbulence, eventually reaches the layer of accumulated smoke aloft. At that instant all along the valley the smoke is swept down to the valley floor in high concentrations, in the manner shown in Fig. 4.

This fumigation, first described by Hewson (3) in connection with the Trail investigation, is found in many valleys and over level terrain as well. In valleys which lie at right angles to the wind which prevails above the valley there is a daytime counterpart to this local flow in the form of a gentle upvalley wind which is characterized by a considerable thermal turbulence and represents a most favorable regime for dispersion.

Plant Location In a Valley

This valley effect provides a clear cut answer to a typical question which may confront an engineer. A new power plant or factory which is likely to be a major source of sulfur dioxide is to be built near a city situated in such a valley. Should the site chosen be upvalley or downvalley from the city? The two possibilities are illustrated in Fig. 5.

If the power plant is erected upvalley from the city, an early morning fumigation by a high concentration of sulfur dioxide will be a fairly regular occurrence, and one felt equally in all parts of the city. The high concentrations can be expected to last for about half an hour.

If the plant is erected downvalley from the city, most mornings the stack effluent flows downvalley away from the city which is thus not affected by the early morning fumigation. When winds do shift towards the city, favorable diffusion will rapidly disperse the sulfur dioxide and prevent any nuisance.

Clearly the plant should be erected downvalley from the city. Then as the city grows and the distance between the plant and the city lessens, it may become advisable to zone adjacent areas for industry and encourage residential expansion on the far side of the city where the influence of the plant during the daytime will be much less.

Control of Effluent Release

If the plant has already been erected upvalley from the city, it may be necessary to consider varying the effluent release, as by burning low sulfur coal or other means, during the early morning hours when inversion conditions prevail. Meteorological control of this type was adopted in the operation of the Trail smelter (4); here the Dwight and Lloyd lead roasters were frequently shut down in the critical early morning hours if the atmospheric conditions were such as to cause fumigation if preventive action was not

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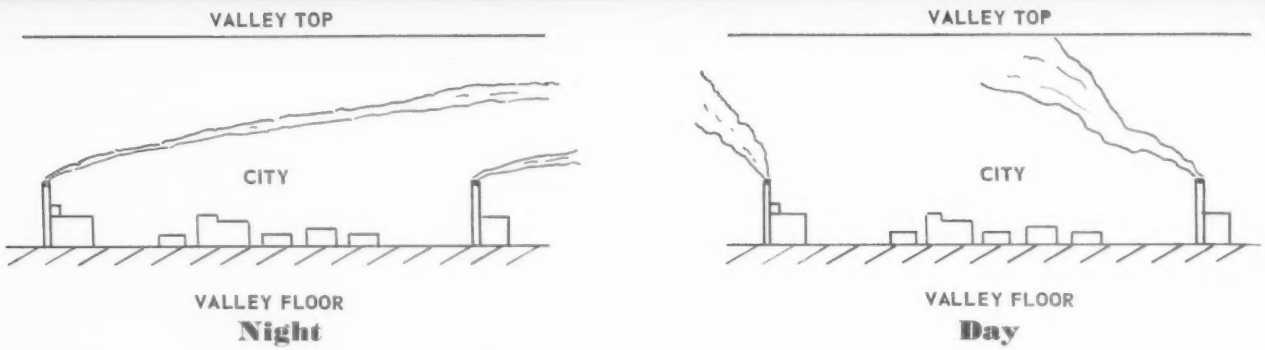

Fig. 5: *Alternate plant locations, either upvalley or downvalley from a city. If plant is located upvalley, the downvalley wind at night will carry SO_2 over the city, to descend as a fumigation when inversion break-up occurs in AM. Preferable plant location is downvalley from the city, which is then not subject to inversion break-up fumigations. Daytime diffusion is good due to upvalley winds.*

(Continued from preceding page)

taken. Where plant operations permit, meteorological control may be effective in many locations other than in a valley.

Adequacy of Meteorological Facilities

When charges of an air pollution nuisance are made, almost the first question asked is, "What was the wind direction?"

The question sounds trivial; in fact it is anything but trivial. If it becomes necessary to establish the wind direction in a court of law, anything less than the record of an automatically recording wind vane or the written record in an official United States Weather Bureau log will be treated as idle hearsay.

Moreover, even if the authenticity of the observation of wind direction is unquestioned, the representativeness of the particular observation may become a very live issue. The routine observation of wind direction that is available through the United States Weather Bureau is likely to have been made at the nearest airport where the wind has a good fetch in all directions, or on top of a federal building a few hundred feet above all but the tallest stacks.

Whether or not it is a reliable indication of the wind in the city nearby, perhaps located in a small valley or beside a lake, is a question that experts may sometimes disagree on. Often the course of wisdom is the installation of a recording anemometer for wind speed and a vane for wind direction as close to the suspected source as possible.

Check Meteorological Instrumentation

The engineer will find that it is good practice, and time well spent, to take stock of the existing facilities for weather observing in his community. In doing so he should keep in mind that the primary meteorological variables are wind direction, wind speed, wind turbulence, and inversions. Many types of recording anemometers are available which provide records of all three characteristics of the wind (5). If one of these is in operation, and if it can be established that it is representative for the area of interest to the engineer, then he need not consider a special installation.

The most likely source of data on inversions is provided by the special soundings of the atmosphere that are taken twice daily at a number of places by government agencies. In these soundings, thermometers and other instruments are carried aloft by freely rising balloons and observed temperatures are transmitted back to the ground by radio.

Generally, from the point of view of air pollution, the twice daily frequency of observations is inadequate. In addition, soundings that are taken to obtain information about higher layers of the atmosphere may not reveal important facts about the lower layers.

The Need for Expert Advice

Specific recommendations are difficult to offer here. It is probably advisable in most cases to engage the services of a meteorologist as a consultant to assist in an evaluation of the available meteorological facilities. If they are deemed adequate, the engineer has located an expert witness who can, if the need ever arises, testify to that effect in a court of law. If they are inadequate, the meteorologist will be needed to design a facility that fulfills the requirements.

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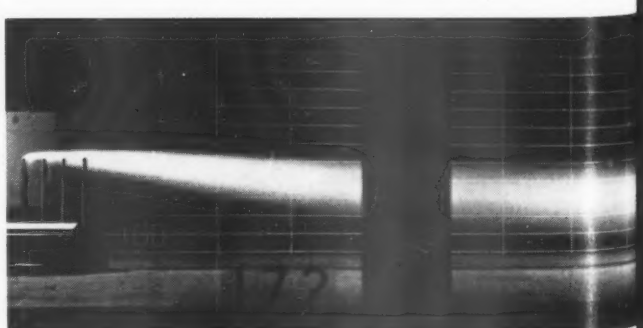

Fig. 6: *Aerodynamic downwash of stack effluents are evaluated by means of model studies in a wind tunnel. (After Sherlock and Lahser.)*

Tips on Fan Selection

(Continued from page 33)

Examples indicated have been at standard air without considering the possibility that the elevated temperature fan may also be subjected to altitude conditions.

Table D gives multipliers for inlet temperature in degrees F, at altitude in feet. For example, at 600 F and sealevel, the multiplier is 2.0 times the "HOT STATIC PRESSURE" at inlet, resulting in the COLD static pressure at sealevel.

At 10,000 ft. inlet temperature at 600 F, the multiplier would be 2.90 times the "HOT STATIC PRESSURE" at inlet, for cold sp. The reciprocal of these numbers multiplied by the cold sp will result in the bhp and sp conditions at elevated temperatures, if only the cold sp is known.

Brake Horsepower Requirements

In most industrial applications, static pressure and brake horsepower requirements are considerably higher than outlined in the examples. It is not uncommon to have bhp requirements for industrial furnaces as high as 25 to 150 hp cold. Often it is possible to install by-pass equipment to permit the furnace to start at cold temperature. Then as the interior becomes warm – say to 600 F – permit the controls to cut in the fan equipment, open the by-pass. Thus the bhp requirements would be just 50 percent that at 70 F. Often by careful consideration, it is possible to use considerably lower horsepower in motors than at 70 F. Individual requirements will determine motor horsepower requirements.

Simple difficulties in heat fan application can be eliminated by following a careful plan of action.

Be sure all sheaves are dynamically balanced. Use heat-resistant v-belts, and always use ball bearing motors. If the application is one where considerable ambient temperatures may be involved, bear in mind that totally enclosed fan cooled motors are not often desirable as the interior heat in these motors cannot be dissipated as readily as open motors.

During initial installation permit the fan to adjust to the temperature conditions before bolting down tightly. On the inlet and outlet use expansion type ductwork for proper and reasonable expansion from cold to hot temperatures.

Above all, give the heat fan bearings care. Over-greasing or over-oiling is sometimes a source of maintenance problems.

If ovens and furnaces are shutdown over week-ends or vacation periods always run the fan equipment through the shutdown cycle (maximum temperature to almost room temperature). Never permit a heat fan to bear the brunt of elevated temperatures standing motionless. The fan wheel and shaft are conductors of temperature.

Heat fan application is barely scratching the surface. Fan manufacturers who have ventured into this field devote considerable time to research and development.

Industry is reaching into higher temperature levels. Heat fan manufacturers are attempting to produce equipment that will stand up to punishment of temperatures as high as 2,000 F – points where most metals become "plastic."

As heat-resistant alloy steels are discovered and evaluated by fan manufacturers, it is not improbable that elevated temperature fan equipment can be designed and operated satisfactorily. ▲▲

Table D

PRESSURE CORRECTION FACTORS FOR ALTITUDES AND TEMPERATURES

Table Basis (Factor 1.00): Altitude 0; Standard Air at 70 F

Chart below may be used for convenience in arriving at the combined temperature and altitude correction factor.

ALTITUDE	INLET TEMPERATURE IN DEGREES, FAHRENHEIT																										
IN FEET	40	50	60	70	80	100	120	140	160	180	200	250	300	350	400	450	500	550	600	650	700	750	800	1000	1200	1400	1600
0	.94	.96	.98	1.00	1.02	1.06	1.09	1.13	1.17	1.21	1.25	1.34	1.43	1.53	1.62	1.72	1.81	1.90	2.00	2.10	2.19	2.28	2.37	2.75	3.13	3.51	3.89
250	.95	.97	.99	1.01	1.03	1.07	1.11	1.14	1.18	1.22	1.26	1.35	1.45	1.54	1.64	1.74	1.83	1.92	2.02	2.12	2.21	2.31	2.39	2.77	3.15	3.54	3.92
500	.96	.98	1.00	1.02	1.04	1.08	1.12	1.15	1.19	1.23	1.27	1.36	1.46	1.56	1.65	1.75	1.85	1.94	2.04	2.14	2.23	2.33	2.41	2.80	3.19	3.58	3.95
750	.97	.99	1.01	1.03	1.05	1.09	1.13	1.17	1.20	1.24	1.28	1.38	1.48	1.57	1.67	1.77	1.86	1.96	2.06	2.16	2.25	2.35	2.43	2.83	3.23	3.61	4.01
1000	.98	1.00	1.02	1.04	1.06	1.10	1.14	1.18	1.22	1.26	1.29	1.39	1.49	1.59	1.69	1.79	1.88	1.98	2.08	2.18	2.27	2.37	2.46	2.85	3.26	3.65	4.04
1500	1.00	1.02	1.04	1.06	1.08	1.12	1.16	1.20	1.24	1.28	1.32	1.42	1.52	1.62	1.72	1.82	1.92	2.02	2.12	2.22	2.32	2.42	2.49	2.91	3.32	3.73	4.12
2000	1.02	1.04	1.06	1.08	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.45	1.55	1.65	1.75	1.86	1.96	2.06	2.16	2.26	2.36	2.47	2.52	2.96	3.38	3.80	4.20
2500	1.04	1.06	1.08	1.10	1.12	1.16	1.20	1.25	1.29	1.33	1.37	1.47	1.58	1.68	1.79	1.89	1.99	2.10	2.20	2.31	2.41	2.51	2.60	3.03	3.44	3.87	4.27
3000	1.06	1.08	1.10	1.12	1.14	1.19	1.23	1.27	1.31	1.36	1.40	1.50	1.61	1.72	1.82	1.93	2.03	2.14	2.24	2.35	2.46	2.56	2.65	3.09	3.51	3.94	4.36
3500	1.08	1.10	1.12	1.14	1.16	1.21	1.25	1.29	1.34	1.38	1.42	1.53	1.64	1.75	1.85	1.96	2.07	2.18	2.29	2.40	2.50	2.61	2.70	3.13	3.57	4.00	4.43
4000	1.10	1.12	1.14	1.16	1.19	1.23	1.28	1.32	1.36	1.41	1.45	1.56	1.67	1.78	1.89	2.00	2.11	2.22	2.33	2.44	2.55	2.66	2.74	3.17	3.62	4.08	4.51
4500	1.12	1.14	1.16	1.19	1.21	1.25	1.30	1.34	1.39	1.43	1.48	1.59	1.70	1.81	1.93	2.04	2.15	2.26	2.38	2.49	2.60	2.71	2.79	3.23	3.69	4.15	4.59
5000	1.14	1.17	1.19	1.21	1.23	1.28	1.32	1.37	1.42	1.46	1.51	1.62	1.74	1.85	1.96	2.08	2.19	2.30	2.42	2.54	2.65	2.76	2.84	3.30	3.75	4.23	4.66
5500	1.16	1.19	1.21	1.23	1.26	1.30	1.35	1.40	1.44	1.49	1.54	1.65	1.77	1.88	2.00	2.12	2.23	2.35	2.47	2.58	2.70	2.81	2.89	3.35	3.82	4.29	4.74
6000	1.19	1.21	1.23	1.26	1.28	1.33	1.38	1.42	1.47	1.52	1.57	1.68	1.80	1.92	2.04	2.16	2.28	2.40	2.51	2.63	2.75	2.87	2.96	3.44	3.91	4.40	4.86
6500	1.21	1.23	1.26	1.28	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.71	1.84	1.96	2.08	2.20	2.32	2.44	2.56	2.68	2.80	2.92	3.00	3.48	3.96	4.47	4.94
7000	1.23	1.26	1.28	1.30	1.33	1.38	1.43	1.48	1.53	1.58	1.63	1.74	1.87	2.00	2.12	2.24	2.36	2.49	2.61	2.74	2.86	2.98	3.03	3.56	4.06	4.58	5.05
7500	1.26	1.28	1.31	1.33	1.36	1.41	1.46	1.51	1.56	1.61	1.66	1.78	1.91	2.04	2.16	2.29	2.41	2.54	2.66	2.79	2.91	3.04	3.15	3.65	4.15	4.68	5.17
8000	1.28	1.31	1.33	1.36	1.38	1.43	1.48	1.54	1.59	1.64	1.69	1.82	1.94	2.07	2.20	2.33	2.46	2.58	2.71	2.84	2.97	3.10	3.20	3.70	4.21	4.75	5.25
8500	1.30	1.33	1.35	1.38	1.41	1.46	1.51	1.57	1.62	1.67	1.72	1.85	1.98	2.11	2.25	2.38	2.51	2.63	2.77	2.90	3.03	3.16	3.24	3.76	4.28	4.82	5.31
9000	1.32	1.35	1.37	1.40	1.43	1.48	1.53	1.59	1.64	1.69	1.74	1.87	2.00	2.14	2.27	2.42	2.54	2.68	2.80	2.93	3.06	3.20	3.32	3.85	4.37	4.92	5.42
9500	1.34	1.37	1.39	1.43	1.46	1.50	1.55	1.61	1.66	1.73	1.77	1.90	2.05	2.19	2.31	2.47	2.59	2.74	2.85	3.00	3.14	3.25	3.38	3.92	4.47	5.02	5.53
10000	1.36	1.39	1.42	1.45	1.49	1.52	1.57	1.63	1.68	1.75	1.80	1.93	2.07	2.21	2.35	2.51	2.63	2.77	2.90	3.03	3.18	3.30	3.44	3.97	4.55	5.05	5.57

If Beryllium comes to your plant . . .

Techniques for Control of Beryllium Dust

Beryllium dust presents tough dust control, ventilation and air pollution problems. This series of articles offers valuable data in control methods for air engineers.

by W. B. Harris, A. J. Breslin, *Health and Safety Laboratory*, and Merrill Eisenbud, *New York Operations Office*, *Atomic Energy Commission*

BECAUSE BERYLLIUM IS finding increased industrial use as an alloy to strengthen copper, stiffen springs, switches, bellows, bearings, and other critical operating parts of electronic and mechanical units; because it boosts efficiency of nuclear reactors, and is important as a structural material in rockets and guided missiles, a review of the hazards and ventilation problems surrounding its use will be of value to air engineers.

Beryllium is slightly heavier than magnesium, 70 percent as heavy as aluminum and is 40 percent stiffer than steel. It presents definite health hazards both within the plant from toxic effects of beryllium dust, and outside the plant from beryllium dust emitted into the air. In the following pages and in this and future articles, we will review first the problems of dust control outside the plant, then take up dust collection inside the plant.

Highly Toxic

Much more than is true with uranium, (see AIR ENGINEERING, June, p. 40 and July, p. 31), the thoroughness of dust control is most exacting; therefore this article will also be valuable to those air engineers who have highly toxic dusts to cope with.

Here is a classic case of beryllium contamination, from which was established the first outplant MAC (maximum allowable concentration) of beryllium dusts in the general atmosphere surrounding plant area, as well as techniques of collection and control. This MAC still stands and is the accepted criterion for pollution control equipment in beryllium processing and fabricating plants.

Sometime in early 1948, nine cases of chronic berylliosis had been reported in the neighborhood surrounding a single plant in Lorain, Ohio, operated by the Brush Beryllium Co., which then produced all of the metallic beryllium, a large portion of the beryllium oxide and much of the beryllium copper in this country. The plant then employed 250 people in the production area. Significant materials handled in the plant were: beryl ore, fritted ore, sulfuric acid, beryllium sulfate, beryllium oxide, beryllium hydroxide, ammonium beryllium fluoride, ammonium bi-fluoride, beryllium fluoride and beryllium metal. Fig. 1 shows flow of materials through the plant.

Two Studies Made

Two intensive and concurrent studies were at once undertaken by both the AEC Health and Safety Laboratory, and the Ohio State Board of Health to determine cause and extent of the illness. Plant management offered free X-rays to persons in the vicinity. These X-rays were taken by the Ohio State Board of Health, which obtained chest X-rays of approximately 10,000 people in the area. Two additional cases of chronic berylliosis were discovered during the X-ray study. Fig. 2 shows location of the plant and locations of all 11 cases of illness. Table 1 shows number of cases in relation to their distance from the plant; up to ¼ mile from the plant.

It should be emphasized that none of the 11 persons listed had any direct contact with beryllium, except one woman whose residence was about two miles from the plant. She was the wife of a plant worker and had laundered work clothes belonging to her husband during his time of employment.

Concurrent with the X-ray study, an intensive study of beryllium contamination of the atmosphere in the vicinity of this plant was initiated by the AEC Health and Safety Laboratory, with the assistance of plant management, as soon as it was suspected that residents of the community were being affected.

The data were obtained in two different groups. One group represents concentrations measured downwind of the plant by collecting samples from a vehicle. This vehicle was equipped with a power supply for operating the sampling equipment. The second group of data was gathered by fixed monitoring stations operating continuously 24 hours a day. All samples in group 1 were collected on Whatman #41 filter paper at a flow of 100 linear ft. per minute. Those in group 2 were collected on "all dust" respirator filters #BM2133. All were analyzed spectrographically, after wet digestion.

Downwind Samples

In order to measure the fall-off of beryllium contamination downwind from the plant under normal conditions of operation, observations were made at various intervals, from ¼ to 20 miles. (See Fig. 3.) In addition, three sets of observations were made approximately 400 ft. downwind of the plant in order to observe specifically the effects of beryllium copper processing on the neighborhood concentrations. Three runs covering 67, 54, and 177 hours of continuous sampling were performed with results as given in Table II.

Continuous Sampling Stations

When the decision to establish fixed monitoring stations was made, the beryllium-affected persons who were then known all resided within a few hundred feet of the plant, and four stations were installed at distances of 350 to 750 ft. from

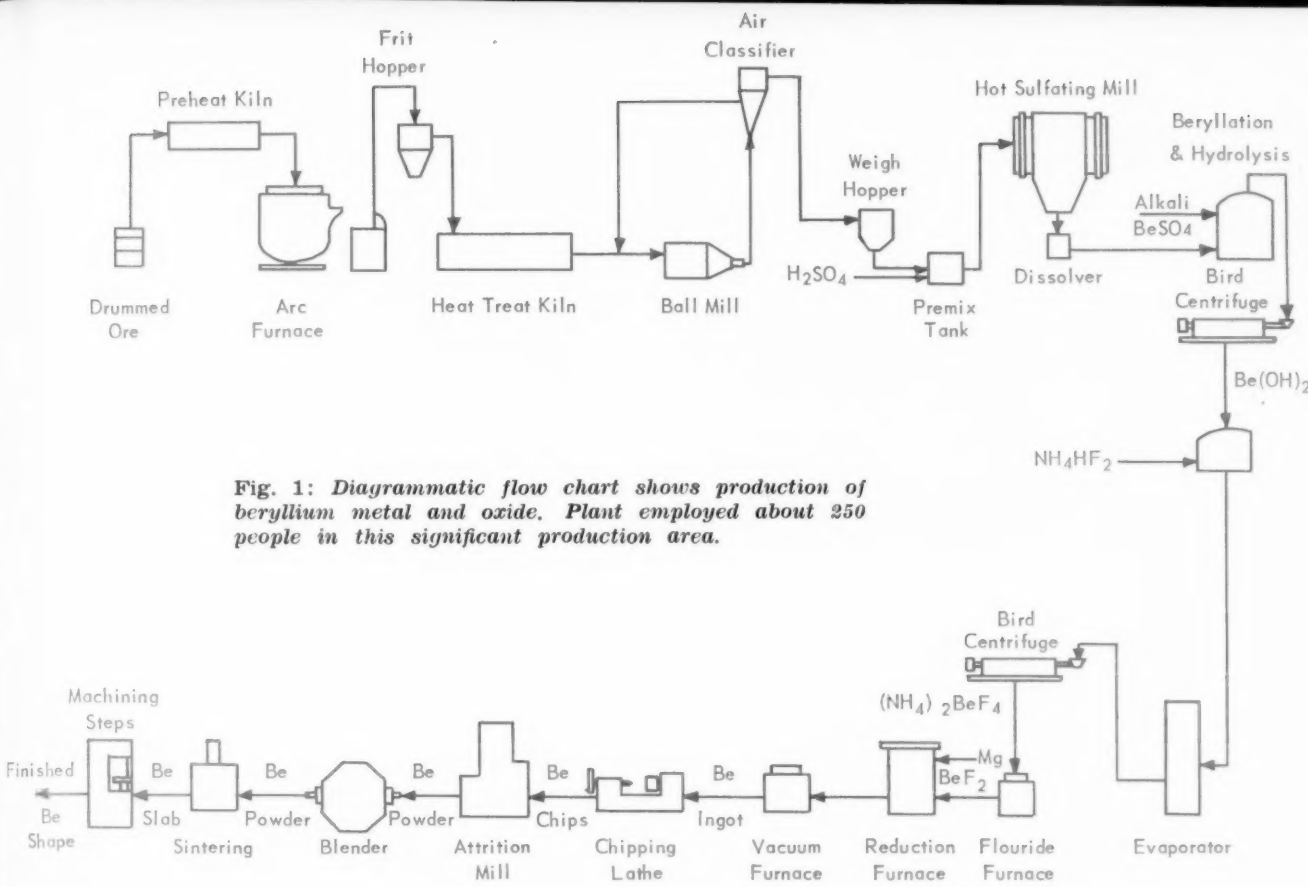

Fig. 1: ***Diagrammatic flow chart shows production of beryllium metal and oxide. Plant employed about 250 people in this significant production area.***

the plant in order to satisfy the need for information in this area. Later, a fifth station was established 7000 ft. from the plant.

Data were collected from these stations continuously for ten consecutive weeks of normal plant operation. On any given day the individual average concentrations reported for the three stations located directly in front of the plant varied by as much as a factor of 100, and the spread in concentrations over the ten-week period was even more marked. However, when averaged over the full ten-week period, the data showed excellent agreement. (Table III.)

Evaluation of Sampling Data

The important plant processes had been essentially unchanged during the important production period. Units of operation had been added during the seven years, but no important ones had been discontinued. Any difference in atmospheric contamination from the past to the sampling period would thus be due to (1) variations in the kind and over-all amount of material being processed, and (2) alterations in the method of handling the exhaust air.

TABLE 1—WHERE CHRONIC BERYLLIOSIS OCCURRED

Distance from Plant	No. of Cases
0 to ¼ mile	5
¼ to ½ mile	3
½ to ¾ mile	2
¾ to 1 mile	0
1 to 1½ miles	0
1½ to 2 miles	1
over 2 miles	0

Variations In Production

The production records of this

(Please turn to following page)

Fig. 2: ***Location of plant and of all cases of chronic berylliosis are shown on aerial view of Lorain, Ohio. Note that location of all illnesses but one are within ¾ mile of the plant.***

(Continued from preceding page)

plant were examined and it was found that from 1941 to 1949 there was no great change in the total amount of material being processed. A factor of 2 would more than cover the greatest quantity of material processed during the peak years compared with the production rate during the period of study. These data are shown in Table IV.

Handling of Discharge

The gaseous effluent from this plant consisted almost entirely of contaminated air exhausted by a rather extensive system of local exhaust ventilation. The effluent was discharged from a 185 ft. stack and also from a number of roof top stacks approximately 35 ft. above street level. From meteorologic considerations, it can be demonstrated[2] [3] that the distribution of cases shown in Table I points to the roof level effluent as being of primary significance in the causation of these cases. Of particular importance in this regard is the fact that 5 of the 11 cases occurred among persons who lived within ¼ mile of the plant, and none are known to exist among those beyond the ¾ mile radius.

Next month, Part II of this article will show how the MAC for beryllium in outside air was established, and what was done in this plant to control emmissions. ▲▲

TABLE 2—CONCENTRATIONS IN IMMEDIATE NEIGHBORHOOD

Test	No. Hrs.	Description	μg/M³ Average Concentration	μg/M³ Range
A	54	BeCu manufacture, plus normal plant operations	0.7	.22–2.2
B	67	Normal plant operations	0.3	.06–.91
C	177	BeCu manufacture, plus normal plant operations	0.7	.4–2.0

TABLE 3—RESULTS OF CONTINUOUS SAMPLING

Station	Feet from Plant	μg/M³ Average Concentration	μg/M³ Range
1	350	.15	.000–2.1
2	750	.05	.000–.280
3	420	.1	.000–1.100
4	650	.05	.000–.460

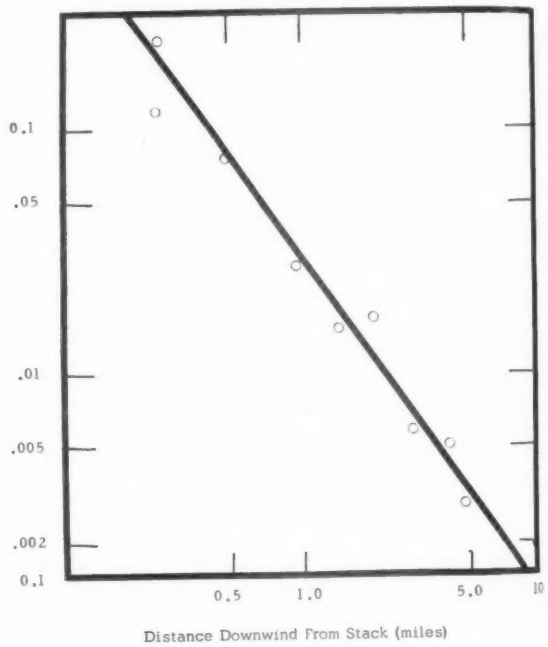

Fig. 3: *Right, graph shows fall-off of ground level concentration of beryllium dusts, with distance from plant, as determined by observation.*

TABLE 4—CHANGES IN MEANS OF EFFLUENT DISPOSAL AND THEIR INFLUENCE

Date of Change	Change or Addition	Est. 185 Ft. Stack Effluent gm/day (before change)	Est. Roof Effluent gm/day (before change)	
2/44	Cottrell added to sulfating mill—connected to stack	1700	5000	
6/45	Fluoride furnace connected to stack	1800	4900	
6/46	Collector provided for ore crusher*	——	no data	
2/47	Scrubber added to fluoride condenser	3100	no change	
7/47	Larger scrubber added to ammonium fluoride condenser	2800	no change	
8/47	Dust collector added to beryl furnace*	no data	no data	
2/48	BeCu furnace operation ceased	no change	3500	
4/9/48	High frequency connected to stack	2300	1200	Period of Test
5/5/48	Wet plant to connected stack	negligible change	negligible change	Period of Test

*This unit is of intermittent operation. No noticeable elevation of neighborhood concentrations occurred when the beryl furnace or ore crusher was in operation.

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Harvard University
and **Charles E. Billings*****
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RESEARCH PROMISES . . .

*Low Cost Cupola Dust Collector** PART II

ABSTRACT

Many processes produce fine particles (0.5μ) suspended in gases at 1000 F or higher, and in current practice temperatures are reduced to utilize available commercial gas cleaning equipment such as electrostatic precipitators, bag filters, etc. Due to high costs of present cleaning methods and increased use of higher temperature operations, there exists a need for devices which will clean gas effectively and inexpensively at elevated temperatures.

Research and development on removal of fine iron oxide aerosols from 1000 F gases reported here is divided into two phases: (1) studies of particle agglomeration by thermal, mechanical devices; and, (2) use of refractory mineral wool fibers for filtration. Successful filtration of iron oxide particles (open hearth furnace fume) has been accomplished in laboratory and field units, and use of rotary agglomerators improves efficiency and extends filter life.

A new cleaning technique for dry filters using blast waves created by exploding diaphragms improves over-all life of the filter. Results of these studies can be applied to effluents from gas turbines, air or gas cooled nuclear reactors, incinerators, boiler flue gases, and many metallurgical processes.

FUNDAMENTALS OF AGGLOMERATION and methods for increasing it were discussed in the first part of this continuing series, which appeared in the July issue of AIR ENGINEERING. Part II describes the performance of a rotary screw agglomerator and filtration at high temperatures.

In order to promote additional agglomeration of fume in flowing gases at high temperature, the rotary screw agglomerator shown in Fig. 1 has been developed and tested on laboratory and field iron oxide fumes. It consists of a standard conveyor screw mounted in a cylindrical sheet steel casing, with tangential entry and exit and provision for rotating the screw.

This provides an extended gas path for operation of diffusional coagulation, extended surface for thermal and contact agglomeration, and a circular or rotary path for action of centrifugal force and also as a means of collecting agglomerates. Turbulance is present as the gas spirals through the screw, and additional turbulence can be introduced by rotating the screw counter-flow.

Aerodynamic characteristics of rotary screw agglomerators have been investigated for 3, 6, 12 and 24 in. diameter units (Table 3). Resistance to gas flow for tangential inlet and outlet connections (Fig. 1) varied as the square of the mass velocity, G, pounds per second per square foot, the proportionality constant being about ¼.

Resistance of the helical spiral channel only was correlated in terms of the Fanning friction factor (f) as a function of Reynolds number, and it was found that (f) was about 1.5 times greater than values reported for commercial steel pipe, over the range of N_R from 10^4 to 1.5×10^5, for 3.6, and 12 in. models (8).

The friction factor for the 24 in. model was about three times

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* Presented at the Semi-Annual Meeting, American Society of Mechanical Engineers, St. Louis, Mo., June 14-18, 1959. This report is based upon work performed under a contract between Harvard University and the American Iron and Steel Institute, through its subcommittee on Air Pollution Abatement.

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TABLE 3

Characteristics of Experimental Rotary Screw Agglomerators

Nominal Diameter, Inches	3	6	12	24
Actual Diameter, Inches	2¾	6	12	24
Pitch or Lead, Inches	2	6	12	24
Screw Length, Inches	24	36	84	140
Number of Screw Turns	12	6	7	6
Shaft Diameter, Inches	1	2½	3	4½
Inlet and outlet Size[a], Inches	1½ID	3½ID	6ID	In 24 × 4¾ Out 12 ID
Cross-Section of Gas Path[b], Square Feet	0.011	0.080	0.38	1.625
Hydraulic Radius of Gas Path, Feet	0.025	0.062	0.136	0.289
Total Length of Gas Path, Feet	7.3	7.8	17.5	29.9
Spiral Channel Reynolds Number	10^4 — 1.5 × 10^5	10^4 — 1.5 × 10^5	10^4 — 1.5 × 10^5	1.5 × 10^5 — 3.5 × 10^5
Overall Resistance[c], Inches, Water	7.2	3.0	2.5	2.2
Gas Flow, cfm, STP	38	200	600	2400
Collection Efficiency[d], Percent	47LF	15LF	40FF	44FF
Spiral Channel Friction Factor (f)	0.013-0.0085	0.013-0.0085	0.013-0.0085	0.026

a. *Twenty-four inch model constructed with slotted inlet extending across two adjacent flights.*
b. *Assumed from a plane passing through the screw axis.*
c. *Inlet velocity 3000 feet per minute at stated gas flow.*
d. *LF = laboratory fume simulant, FF = field open hearth fume.*

(Continued from preceding page)
higher than predicted by correlations for the smaller units, being about 2.6 × 10-² for N_R between 1.5 and 3.5 × 10^5 (9). This higher value is apparently due to effects of a different tangential slotted entry on the gas flow pattern within the flights (Fig. 2).

Iron oxide fume removal efficiency is indicated in Table 3 for uninsulated screw units having some form of collecting hopper (except for the 6 in. unit which had no hopper). Removal efficiency with the 3 in. diameter unit thermally insulated was essentially zero, on laboratory fume simulant, indicating that thermal gradients improve particle size growth and collection (by thermal deposition and reentrainment).

Degree of agglomeration of fume in screw agglomerators has been studied in three ways; by electron photomicrographs of fume particles up and downstream of the screw, by examination of efficiency of size selective sample collectors on inlet and outlet of fume, and by determining rate of increase of resistance of a slag wool filter unit following the agglomeration (for the 12 in. unit).

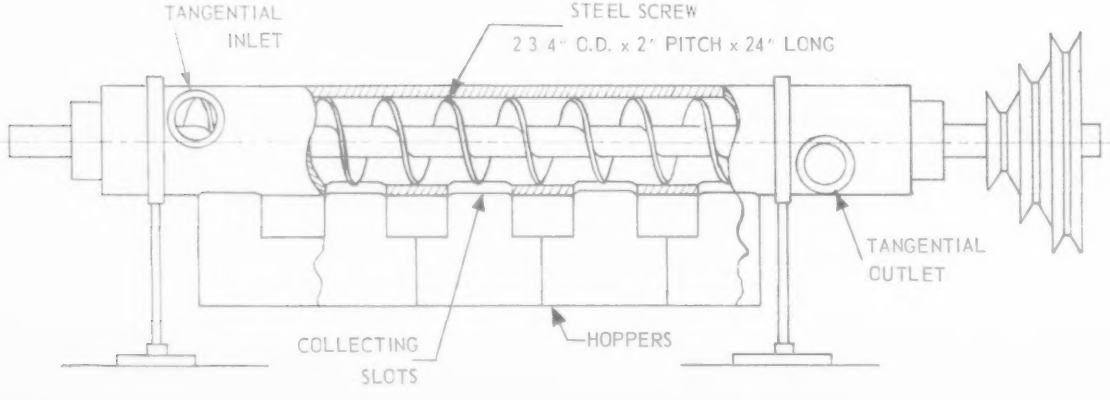
Analysis of electron microscope samples is presented in Table 4 for the 12 and 24 in. diameter units. Columns 2 and 5 of Table 4 present the count median diameters (Mg) of fume particles entering and leaving agglomerators. Particle size of fume leaving the 12 in. unit was larger than inlet fume in two out of three simultaneous samples (numbers 1, 3, and 4). Average increase in fume particle size is about 13 percent by count.

Columns 4 and 7 show inlet and outlet mass median diameters (Mg'), respectively. The average increase in MMD is over 400 percent, due to the increased dispersion caused by agglomeration. Particles have been increased in size from less than one-half micron (MMD) to over 2 microns in passage through the 12 in. agglomerator.

The agglomerator produces a greater degree of heterogeniety of the outlet fume as indicated by the rather large increase in standard geometric deviation (σg) evident in outlet samples. As previously discussed, agglomeration will generally tend to make a particulate cloud more heterogeneous with respect to particle size because there is a tendency for larger particles to act as targets for further agglomeration of the finer particles (i.e. the larger particle occupies a greater space and is more likely to collide with smaller particles).

Calculations of unaided diffusional coagulation by Equation 2

Fig. 1: *Rotary screw agglomerator shown below was designed to promote additional agglomeration of fume in flowing gases at high temperatures. This is horizontal unit.*



EXPERIMENTAL SCREW-AGGLOMERATOR

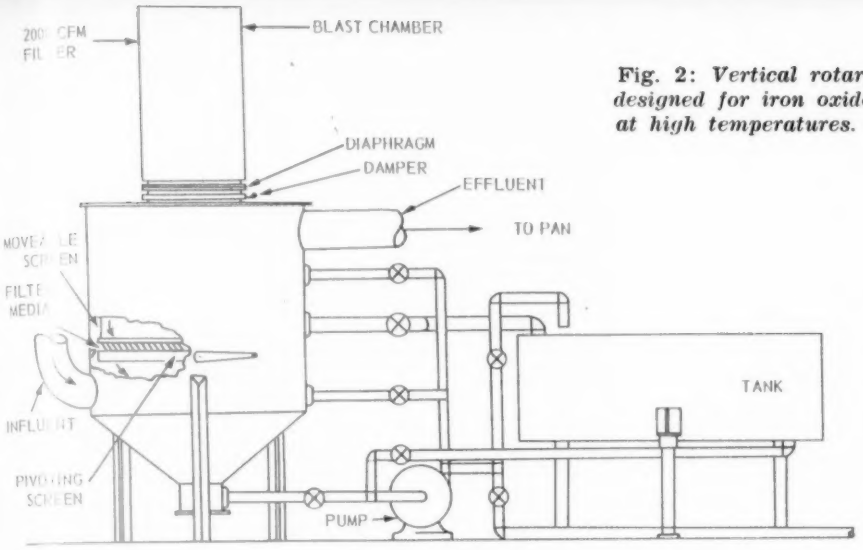


Fig. 2: *Vertical rotary screw agglomerator is shown at left, designed for iron oxide and similar fume removal from gases at high temperatures.*

indicate a very small decrease in particle numbers (i.e. little agglomeration) during passage through the 12 in. screw (4.7×10^7 p./ml. initially to 4.6×10^7 p./ml. finally) after exposure of 0.32 sec. in the screw channel. The calculated number concentration of the outlet fume based on assumed homogeniety at 0.17μ is 1.4×10^7 p./ml. (i.e., from the outlet particle size, and loading).

The 24 in. unit tests indicate that in two out of three tests, the outlet fume particle size is larger than the inlet size, and on the average substantial agglomeration has taken place by passage of the fume through the agglomerator. Columns 2 and 5 (Table 4) show comparative count median diameters. Average increase is about 81 percent. The average mass median diameters of outlet samples is reduced by about 10 percent, and the standard geometric deviation is unchanged in this case.

A calculation of decrease in number concentration due to unaided diffusional coagulation during the period that the fume is within the helical channel (0.84 sec.) indicates that little of the agglomeration occurs due to this mechanism. The agglomerator enhances particle collision frequency through turbulence, thermal and velocity gradients, and by deposition on casing walls with subsequent reentrainment.

Other methods for measuring performance of rotary screw agglomerators have been discussed in conjunction with field tests of agglomerator-filter combinations (10). Further agglomeration studies are in progress and will be reported at a later date. ▲▲

Part III of this article, to be presented next month, will take up additional field test data which may lead to practical, workable low cost iron oxide collector.

Definitions

d = particle diameter, microns (μ); $1\mu = 10^{-4}$ cm.

f = Fanning friction factor, dimensionless.

G = mass velocity, pounds/sec./sq. ft.

H = coagulation constant, ml./sec. = $4\ KT/3\mu$.

K = Boltzmanns' constant = 1.38×10^{-16} ergs/°K-molecule.

Mg = count median diameter (CMD), μ.

Mg′ = mass median diameter (MMD), μ.

N_R = Reynolds number, dimensionless.

n = number concentration of particles in aerosol, p./ml.

t = time, sec.

T = absolute temperature, °K.

Δp = resistance, inches of water.

λ = mean free path of air molecules, approx. 10^{-5} cm at 20°C.

μ_a = air viscosity, poise, approx. 1.8×10^{-4} at 20°C.

σ g = standard geometric deviation.

TABLE 4

Performance[a] of Rotary Screw Agglomerators on Iron Oxide Fume

Sample	Particle Size[b], Microns						% Increase		Unit Diameter	
	Inlet			Outlet						
Number	Mg	σ g	Mg′	Mg	σ g	Mg′	Mg	Mg′	Inches	Remarks
1	0.17	1.8	0.47	0.23	2.7	4.9	35	940	12	During lime boil
2	0.09	1.9	0.30	....	..	...	...	...	12	During lime boil
3	0.12	1.9	0.42	0.13	2.1	0.60	8	43	12	During lime boil
4	0.24	1.8	0.70	0.15	2.5	1.9	-38	170	12	During lime boil
Average	0.15	1.8	0.47	0.17	2.4	2.5	13	430	12	.....
5	0.019	1.8	0.049	0.013	2.7	0.32	-32	550	24	During working period
6	0.11	2.1	0.63	0.23	2.1	1.6	109	150	24	During working period
7	0.015	3.4	1.6	0.017	2.3	0.13	13	-92	24	During flush-off period
Average	0.048	2.4	0.76	0.087	2.4	0.68	81	-10	24	.....

a. *Results of electron microscope analysis of inlet and outlet particle size, average magnification 30,000 X.*

b. *Mg = count median diameter, μ, σ g = standard geometric deviation, Mg′ = mass median diameter.*

Tips for Testing Ventilation Systems

PART I

by **Bernard D. Bloomfield**
Industrial Hygienist*

A test in time may save down-time of industrial ventilation systems. To assure safety of operation as designed, here are practical ways to do your own testing of ventilation systems.

TESTING OF VENTILATION SYSTEMS is rarely the routine procedure it should be in a plant, with the result that system failure may develop over a period of months and continue indefinitely without being detected.

Considering the investment – in a new foundry for example, 10 to 15 percent of the initial equipment cost for dust and fume control equipment alone – the justification for periodic testing is apparent. Protection of the health and safety of workers where toxic and/or flammable materials are handled, protection of production equipment as well as product (corrosion, abrasion of bearings, deterioration of plating baths, discoloration or etching of product surfaces) require that a ventilation system perform as the designer intended.

Aside from periodic testing by plant personnel to assure constancy of performance, other testing objectives are as follows:

(1) To determine whether a new system performs according to design specifications.

(2) To determine whether an old system continues to perform satisfactorily.

(3) To determine whether the system meets standards imposed by governmental agencies, the purchaser (company) or trade associations.

(4) To determine whether additional load can be added to system.

Above: *Swinging vane anemometer is shown testing for correct velocity at hood exhaust opening. Instrument can be used for measuring velocity at supply openings and for measuring velocity and static pressure in ducts.*

(5) To enable setting of blast gates on systems designed for blast gate balancing.

In evaluating system performance one may measure air velocity into a hood face opening or slot, static pressure, velocity pressure, duct transport velocities and invariably, air flow rate. Hood face or slot velocities typical of industrial operations are:

Paint spray booths – 100 to 200 fpm at face.

Plating tanks – 2,000 fpm at slot with 100 fpm control velocity at point furthest from slot.

Laboratory hoods – 100 to 150 fpm at face.

Duct velocities – considered *optimum* are 3500 fpm in systems where particulates are conveyed and 2,000 fpm for systems handling fumes, gases or mists.

Measurement of velocity within a duct is usually done indirectly by first determining velocity pressure and from this, the equivalent velocity – based on the equations:

$$V = 4005 \sqrt{VP} \text{ for air at 70 F and 29.92 in. Hg}$$

or

$$V = 1096.5 \sqrt{\frac{VP}{d}}$$

$$\text{and } d = 0.075 \times \frac{530}{460 + t} \times \frac{B}{29.92}$$

where:

V = *velocity in feet per minute..*
VP = *velocity pressure in inches of water*
d = *density of air in lbs. per cubic foot*
t = *temperature in °F*
B = *barometric pressure in inches of Hg*

**Assistant Director, Division of Occupational Health, Michigan Department of Health.*

Static pressure can be measured at any point in a duct system and indicates resistance to flow due to both friction and dynamic (turbulence) losses.

When measured on suction side of fan it indicates pressure drop from hood entry to measurement point and if measured on pressure side it indicates pressure drop from point of measurement to exhaust outlet. *The static pressure measurement at any point in system should correspond to theoretical design calculation value as indicated on design tabulation sheet.*

The static pressure measurement made at the hood throat* following installation and balancing of a system is useful as an index or future reference value but without reference to duct diameter is meaningless as a ventilation standard. It is related to exhaust volume in accordance with the equation:

$$Q = 4005\ Ce\ A\ \sqrt{SP}$$

where:

Q = flow rate in cubic feet per minute

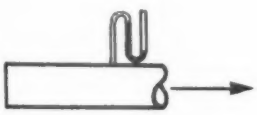
Ce = coefficient of entry for specific hood = $\sqrt{\frac{VP}{SP}} = \sqrt{\frac{VP}{VP + h_e}}$

A = area of duct in square feet

SP = static pressure in inches of water

h_e = hood entry loss in inches of water = SP – VP

VP = velocity pressure in duct



	Ce	*he*
Plain duct end	0.72	0.93
Flanged duct end	0.82	0.49
Standard grinder hood	0.78	0.65

Fig. 1: *Techniques for measuring static pressures at various type of duct applications.*

*Measure throat static about 1 duct diameter downstream from throat of tapered hoods and 3 duct diameters downstream from throat of flanged or plain duct ends. *The static suction figure alone without reference to duct diameter is meaningless as a ventilation standard.*

Static pressure when measured at a fan inlet and outlet enables the determination of total duct system resistance (inlet and outlet portions of system). This is *not* fan static pressure as previously defined by Air Moving and Conditioning Association and as used in most fan rating tables.

By definition (AMCA):

Fan SP = Fan TP – VP (fan outlet), = SP(out – SP(in) – VP(in)

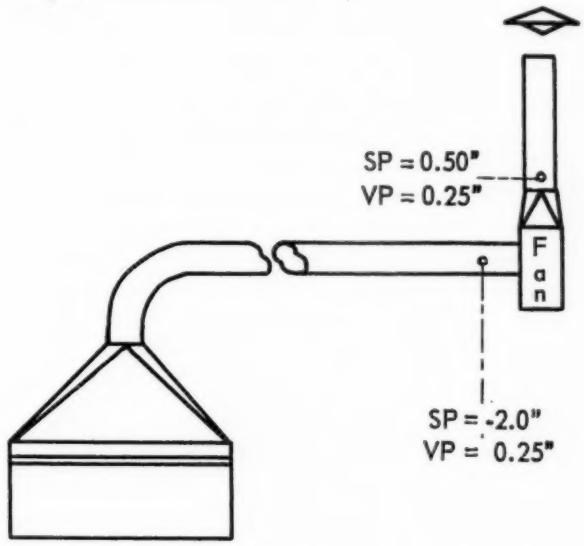
Derivation:

(a) Fan static by definition (AMCA):
TP (fan) – VP (out)

(b) Fan total pressure is difference in absolute pressures:
TP (fan) = TP (out) – TP (in) = [SP (out) + VP (out)] – [SP (in) + VP (in)]

(c) Fan SP = [SP (out) + VP (out)] – [SP (in) + VP (in)] – VP (out)
= SP (out) + VP (out) – SP (in) – VP (in) – VP (out)
= SP (out) – SP (in) – VP (in)

Example:



Design data sheet tabulation of system static pressure = 2.0 + 0.50 = 2.5″. Fan static pressure = SP (out) – SP (in) – VP (in) = 0.5 + 2.0 – 0.25 = 2.25. Therefore if fan multi-rating tables are based on S.P. use fan S.P. If total pressure is used for rating purposes –

TP (for above) = TP (out) – TP (in) = (0.50 + (0.25) – (–2.0 + 0.25) = 2.50″ water

Testing Equipment

A wide variety of testing equipment is available. The most important considerations for all instruments are *calibration* and *reliability*. The Pitot tube (Fig. 2) has been standardized in design (ASHAE, AMCA) is rugged, reliable and accurate. It enables determination of velocity pressure, *usually in a duct* and subsequently by application of the common equations:

$$V = 4005\ \sqrt{VP} \quad \text{and} \quad Q = VA,$$

the flow rate. It is used in conjunction with a manometer. Pitot tubes *other* than the standard type

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require calibration in the flow range to be appraised.

Flow rates can also be determined with venturi and orifice meters and nozzles but these are special purpose instruments not commonly used for testing of duct systems.

The swinging vane anemometer (Velometer), the rotating vane anemometer, the heated thermometer anemometer and the heated thermocouple anemometer are all used for velocity measurement *at exhaust or discharge openings.* They should be handled in compliance with manufacturers' directions and are subject to error depending upon user, condition of equipment and application.

Commonly, a series of velocities are measured at different points and the result averaged. All but the rotating vane anemometer can be used for velocity measurements in ducts but are decidedly inferior to the Pitot tube in both accuracy and ease of use for this purpose.

How To Use Pitot Tube

Static pressure measurements are easily made with the Pitot tube (static pressure element only) or with a piece of rubber tubing held against a 1/16 in. to 1/8 in. drilled hole having no inner projections or burrs. In either case a satisfactory manometer is required.

There is considerable question concerning the accuracy of any of the instruments mentioned when used in the field for measurement of velocities *below 100 fpm. With the exception of the Pitot tube, all require frequent calibration.*

The Pitot tube (Fig. 2) – consists of two concentric tubes, one serving to measure impact (total) pressure and the other to measure static pressure. Both taps are connected across a differential manometer. The pressure reading indicates velocity pressure. The Pitot tube traverse is the method of determining air velocity in a duct, is made whenever possible at a point at least seven diameters downstream from a major disturbance such as an elbow or fitting and in circular ducts should consist of two sets of readings 90° apart.

Each set of readings should be spaced so as to be at the center of annular rings of equal area in circular ducts or, in the case of rectangular ducts, in the centers of a minimum of nine hypothetical squares on at least three lines. For approximate results in circular ducts, a centerline reading can be used, provided that the measurement is preceded by at least 10 diameters of straight duct.

Also it is necessary that the centerline velocity pressure be multiplied by 0.81 or the centerline velocity by 0.90 in order to arrive at a representative velocity measurement. The major limitation of the Pitot tube is its minimum accurately measured velocity of about 800 fpm equivalent to 0.04 in. of water, this limitation being imposed by the readability of the inclined manometer. Impact pressure or static

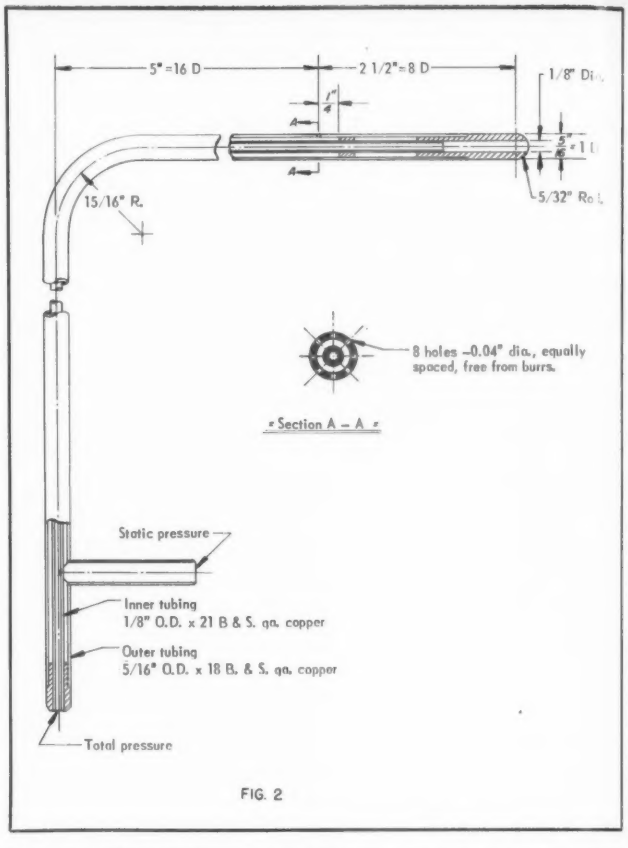

FIG. 2

Fig. 2: ***Pitot tube, shown above, is used to make static pressure measurements, determine velocity pressure in ducts, and check flow rates.***

pressure can be read separately by using the appropriate Pitot tube connections.

The velocity – velocity pressure mathematical relationship is dependent upon air density, necessitating temperature and pressure corrections when the air temperature differs from 70 F and the altitude from 1000 ft. and a velocity pressure equivalent chart based on air at standard conditions is used. Humidity and duct pressures up to 12 in. water do not have sufficient effect on density under normal plant conditions to warrant correction of velocity pressure. Therefore, at normal conditions of temperature and pressure (standard air) $V = 4005 \sqrt{VP}$, upon which most velocity pressure charts are based. Where air density corrections are necessary to enable use of a standard air chart (Table I) it is simply a matter of correcting the measured velocity pressure by the density correction factor as follows:

$$\text{Corrected VP} = \frac{\text{measured VP}}{\frac{530}{460 + t} \times \frac{B}{29.92}} = \frac{\text{measured VP}}{CF}$$

The equivalent velocity found with the "corrected VP" value is the velocity at *existing* duct conditions, not standard conditions.

The swinging vane anemometer (Velometer) shown on page 48 is commonly used for field check purposes (mainly velocity at supply or exhaust open-

TABLE 1*—VELOCITY PRESSURES FOR DIFFERENT VELOCITIES

$$VP = \left(\frac{V}{4005} \right)^2$$

[Velocity (V) in feet per minute and velocity pressure (VP) in inches of water]

VP	V	VP	V	VP	V	VP	V	VP	V	VP	V
0.06	981	0.43	2626	0.80	3582	1.17	4332	1.54	4970	1.91	5535
0.07	1060	0.44	2656	0.81	3604	1.18	4350	1.55	4986	1.92	5550
0.08	1133	0.45	2687	0.82	3625	1.19	4368	1.56	5002	1.93	5564
0.09	1201	0.46	2716	0.83	3657	1.20	4386	1.57	5018	1.94	5579
0.10	1266	0.47	2746	0.84	3669	1.21	4405	1.58	5034	1.95	5593
0.11	1328	0.48	2775	0.85	3690	1.22	4423	1.59	5050	1.96	5608
0.12	1387	0.49	2804	0.86	3709	1.23	4442	1.60	5066	1.97	5623
0.13	1444	0.50	2832	0.87	3729	1.24	4460	1.61	5082	1.98	5637
0.14	1498	0.51	2860	0.88	3758	1.25	4478	1.62	5098	1.99	5651
0.15	1551	0.52	2888	0.89	3779	1.26	4495	1.63	5114	2.00	5664
0.16	1602	0.53	2916	0.90	3800	1.27	4513	1.64	5129	2.01	5678
0.17	1651	0.54	2943	0.91	3821	1.28	4531	1.65	5144	2.02	5692
0.18	1699	0.55	2970	0.92	3842	1.29	4549	1.66	5160	2.03	5706
0.19	1746	0.56	2997	0.93	3863	1.30	4566	1.67	5175	2.04	5720
0.20	1791	0.57	3024	0.94	3884	1.31	4583	1.68	5191	2.05	5734
0.21	1835	0.58	3050	0.95	3904	1.32	4601	1.69	5206	2.06	5748
0.22	1879	0.59	3076	0.96	3924	1.33	4619	1.70	5222	2.07	5762
0.23	1921	0.60	3102	0.97	3945	1.34	4636	1.71	5237	2.08	5776
0.24	1962	0.61	3127	0.98	3965	1.35	4653	1.72	5253	2.09	5790
0.25	2003	0.62	3153	0.99	3985	1.36	4671	1.73	5268	2.10	5804
0.26	2042	0.63	3179	1.00	4005	1.37	4688	1.74	5283	2.11	5817
0.27	2081	0.64	3204	1.01	4025	1.38	4705	1.75	5298	2.12	5831
0.28	2119	0.65	3229	1.02	4045	1.39	4722	1.76	5313	2.13	5845
0.29	2157	0.66	3254	1.03	4064	1.40	4739	1.77	5328	2.14	5859
0.30	2193	0.67	3279	1.04	4084	1.41	4756	1.78	5343	2.15	5872
0.31	2230	0.68	3303	1.05	4103	1.42	4773	1.79	5359	2.16	5886
0.32	2260	0.69	3327	1.06	4123	1.43	4790	1.80	5374	2.17	5899
0.33	2301	0.70	3351	1.07	4142	1.44	4806	1.81	5388	2.18	5913
0.34	2335	0.71	3375	1.08	4162	1.45	4823	1.82	5403	2.19	5927
0.35	2369	0.72	3398	1.09	4181	1.46	4840	1.83	5418	2.20	5940
0.36	2403	0.73	3422	1.10	4200	1.47	4856	1.84	5433	2.21	5954
0.37	2436	0.74	3445	1.11	4219	1.48	4873	1.85	5447	2.22	5967
0.38	2469	0.75	3468	1.12	4238	1.49	4889	1.86	5462	2.23	5981
0.39	2501	0.76	3491	1.13	4257	1.50	4905	1.87	5477	2.24	5994
0.40	2533	0.77	3514	1.14	4276	1.51	4921	1.88	5491	2.25	6008
0.41	2563	0.78	3537	1.15	4295	1.52	4938	1.89	5506		
0.42	2595	0.79	3560	1.16	4314	1.53	4954	1.90	5521		

*From p 6-23 of INDUSTRIAL VENTILATION, American Conference of Governmental Industrial Hygienists.

ings). Operation is based upon deflection of a spring-loaded vane by the air flowing through the instrument. The instrument is directional, requires frequent calibration and adjustment, is fairly rugged but sensitive to dust, condensation and corrosive gases and reads directly in feet per minute. The instrument can be used with a variety of fittings for measuring velocity and supply and exhaust openings and for measuring velocity and static pressure in ducts. In its latter use it is limited because of inherent inaccuracy, the relatively large ($\geq 3/8''$ D) hole required and necessity of perfect alignment. The manufacturer's use recommendations should be followed closely.

On measurements at face openings of less than 3 sq. ft., fittings must be used and these are suited to velocities greater than 250 fpm. At supply openings the instrument (left hand port) or jet should be held between one and two inches in front of any grilles. At exhaust openings the instrument should be held so that the left hand port or jet is flush with the face of the opening. Correction factors for use of the instrument are noted below:

TABLE II—CORRECTION FACTORS FOR THE SWINGING VANE ANEMOMETER (VELOMETER)

Opening	Correction Factor
Pressure	
More than 4 in. wide and up to 600 sq. ft. area, free opening 70 percent or more of gross area, no directional vanes. Use free-open area.	0.93
Suction	
Square punched grille (use free-open area)	0.88
Bar grille (use gross area)	0.78
Strip grille (use gross area)	0.73
Free open, no grille	1.00

Volume: cfm = (factor) (area) (velocity)

*From INDUSTRIAL VENTILATION, American Conference of Governmental Industrial Hygienists.

(Please turn to page 51)

Meteorology

(Continued from page 36)

The issues to be resolved will be the right choice of recording wind equipment, the right place to locate the instrument, the best way to measure inversions if this is considered to be necessary, as well as the possible need for other instruments such as a rain gage (5).

Cost of Meteorological Instrumentation

The air engineer should realize at the outset that precision instrumentation that is capable of operating out of doors for long periods of time with little maintenance is expensive. As far as wind measurements are concerned, standard equipment can be obtained for about $1,500 to $2,000.

If the situation is such that inversions must also be observed, custom instrumentation must be developed from standard components, and again the cost is no small item. On the other hand the costs involved are small in comparison to that of an electrostatic precipitator, or the amount of damages that might be granted because a defendant was unable to document the fact that the wind was not blowing towards the plaintiff at the time of the alleged injury.

Secondary Meteorological Factors

In the account of the primary meteorological factors which has already been given we have pointed out the association between light winds, inversions, and high concentrations of air pollutants. We have also considered some exceptions to this generalized picture.

For example, two instances in which inversions were not associated with high pollution have been given. Two other aspects will now be discussed which help to make the picture more complete and will, at the same time, emphasize the hazards associated with oversimplification.

Aerodynamic Downwash

Although the association of strong winds and pronounced turbulence with low pollution is generally valid and is in practice mostly realized, Sherlock and his associates (6, 7) working with models in a wind tunnel at the University of Michigan uncovered an important exception.

In a series of studies on the behavior of plumes from steam generating plants he demonstrated conclusively that for a given stack, plant configuration, and stack gas velocity there is a critical wind speed above which the smoke is swept down to the ground in the immediate vicinity of the plant. The name *aerodynamic downwash* which Sherlock gave to this phenomenon is now in general use.

Sherlock was able to show, by means of model studies such as that pictured in Fig. 6, that the von Karman or tip vortices set off by the wind as it moved past the stack, and a turbulent region set up as the wind flowed over the power plant, were responsible for downwash. He also demonstrated that the erection of taller stacks and the adoption of stack gas velocities of the order of 90 to 120 fps raised the critical wind speed required for downwash to a value that was experienced quite infrequently.

The complete methodology involves determining that wind speed which is exceeded only 1 percent of the time, and providing a tall enough stack and large enough stack gas velocity to overcome downwash for all lighter winds.

The air engineer should observe that downwash is a neighborhood phenomenon, since the generally favorable dispersion associated with high winds will later diffuse the smoke. He will find it a useful practice to survey the stacks of an area for those which exhibit large effluent-colored stains well below the top since these are the ones which are affected by downwash. He should automatically associate complaints of air pollution registered during periods of moderate to strong wind with the phenomenon of downwash.

Rainfall

Another meteorological variable that sometimes requires consideration is rainfall. Since rainfall may capture particulate contaminants or dissolve gaseous contaminants, rain may either remove pollution before it reaches a neighborhood, or cause them to descend directly upon that neighborhood. Thus rainfall is *a priori* neither a favorable nor an unfavorable influence, but may have to be taken into account in a complete study of an air pollution problem.

Other Weather Elements

As for the other meteorological variables such as temperature, humidity, cloudiness, and solar radiation, their effects are usually small. However, there may be an association between above normal temperatures and high pollution, because the frequency of inversions is greater at these times. This fact was used by Baynton (8) in correlating particulate air pollution with meteorological factors in the Detroit-Windsor area.

Those who are familiar with the Los Angeles smog problem will be aware that photo-chemical reactions take place under the influence of the sun and that the new chemicals which are formed produce much eye irritation. The release of acid mists during foggy weather also can lead to complications. Thus factors which are in general of small importance may assume critical importance when all the elements comprising a given air pollution problem have been pieced together.

Air pollution is one of the problems which cuts across a good many disciplines, and for all but the simplest cases, only an interdisciplinary study can be expected to yield a solution. Most air pollution prob-

(Please turn to page 52)

INDEX OF ADVERTISERS

Aerovent Fan Co., Inc. 6
Agency: Mariva Industrial Advertising

Airtemp Div., Chrysler Corp. .....Back Cover
Agency: Grant Advertising

American Air Filter Co., Inc. ..... *
Agency: Doe-Anderson Advertising Agency

Barber-Colman Co. ..... *
Agency: Howard H. Monk & Associates

Barnebey-Cheney Co. ..... *
Agency: Odiorne Industrial Advertising

Brasch, J. K., Canada Fans Ltd. ... *

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Canada Fans, Ltd. ..... *

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Day Co. ..... *
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Agency: Watkins Rogers, Inc.

Drayer-Hanson Div., Nat'l U. S. Radiator Corp. ..... *
Agency: Lansburgh & Oldham

Ducon Co., Inc. ..... *
Agency: Sam J. Gallay Advertising

Dustex Corp. 53
Agency: Comstock & Co.

F. W. Dwyer Manufacturing Co. 9
Agency: Symonds, Mackenzie & Co.

Easton R. S. Corp. ..... *
Agency: Advertising Techniques

Flexaust Co. ..... *

Gelman Instrument Co. ..... *
Agency: Watkins Rogers, Inc.

Hartzell Propeller Fan Co. ..... *
Agency: Kight Advertising

Heil Process Equipment Corp. ..... *
Agency: Henry T. Bourne Adv. Agency

Illinois Testing Laboratories, Inc.... 54
Agency: The Buchen Co.

Jackson & Church Div. of York-Shipley, Inc. ..... *
Agency: Adams Associates, Inc.

Kirk & Blum Mfg. Co. ..... *
Agency: Bayer, Kemble & Spicer, Inc.

Lennox Industries, Inc. ..... *
Agency: Fulton, Morrissey Co.

Metal Textile Corp. ..... *
Agency: Hicks & Greist, Inc.

Mercoid Corp. ..... *

Wm. W. Meyer & Son, Inc. ..... *
Agency: Slauf Advertising

Niagara Blower Co. 53
Agency: Moss-Chase Co.

Reliance Electric & Manufacturing Co. ..... *
Agency: The Wellman Co.

Research-Cottrell, Inc. ..... *
Agency: Michel-Cather, Inc.

Research Products Corp. 54
Agency: Ralph Timmons, Inc.

Spraying Systems Co. 54
Agency: Advertising Producers-Associated

Staplex Co. ..... *
Agency: Lee Keeler, Inc.

Stoddard Industries 2
Agency: The Caples Co.

The Trane Co. ..... *
Agency: Campbell-Mithun, Inc.

Western Precipitation Corp. ..... *
Agency: Dozier Eastman & Co.

Westinghouse Electric Co., Sturtevant Div. ....Inside Front Cover
Agency: Fuller & Smith & Ross, Inc.

York Corp., Subs. of Borg-Warner Corp. ..... *
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Testing

(Continued from page 49)

The velometer can be obtained in ranges from <100 fpm to 10,000 fpm. *Next Month, Part II.* ▲▲

TABLE III*

Distance from wall of round pipe to point of reading (nearest ⅛ inch) for 10-point traverse. For rectangular duct, take reading at center of at least nine equal rectangles.

Reading	No. of Diam.	Duct Diameter, Inches 4	4½	5	5½	6	7	8	9	10	11	12	14
R1	0.026	⅛	⅛	⅛	⅛	⅛	⅛	¼	¼	¼	¼	⅜	⅜
R2	0.082	⅜	⅜	⅜	½	½	⅝	⅝	¾	⅞	⅞	1	1⅛
R3	0.146	⅝	⅝	¾	¾	⅞	1	1⅛	1¼	1½	1⅝	1¾	2
R4	0.226	⅞	1	1⅛	1¼	1⅜	1⅝	1¾	2	2¼	2½	2¾	3⅛
R5	0.342	1⅜	1½	1¾	1⅞	2	2⅜	2¾	3⅛	3⅜	3¾	4⅛	4¾
R6	0.658	2⅝	3	3¼	3⅝	4	4⅝	5¼	5⅞	6⅝	7¼	7⅞	9¼
R7	0.774	3⅛	3½	3⅞	4¼	4⅝	5⅜	6¼	7	7¾	8½	9¼	10⅞
R8	0.854	3⅜	3⅞	4¼	4¾	5⅛	6	6⅞	7¾	8½	9⅜	10¼	12
R9	0.918	3⅝	4⅛	4⅝	5	5½	6⅜	7⅜	8¼	9⅛	10⅛	11	12⅞
R10	0.974	3⅞	4⅜	4⅞	5⅜	5⅞	6⅞	7¾	8¾	9¾	10¾	11⅝	13⅝

Reading	No. of Diam.	Duct Diameter, Inches 16	18	20	22	24	26	28	30	32	34	36	40
R1	0.026	⅜	½	½	⅝	⅝	⅝	¾	¾	⅞	⅞	1	1
R2	0.082	1¼	1½	1⅝	1¾	2	2⅛	2¼	2½	2⅝	2¾	3	3¼
R3	0.146	2⅜	2⅝	2⅞	3¼	3½	3¾	4⅛	4⅜	4⅝	5	5¼	5⅞
R4	0.226	3⅝	4⅛	4½	5	5½	5⅞	6⅜	6¾	7¼	7¾	8⅛	9
R5	0.342	5½	6⅛	6⅞	7½	8¼	8⅞	9⅝	10¼	11	11⅝	12⅜	13⅝
R6	0.658	10½	11⅞	13⅛	14½	15¾	17⅛	18⅜	19¾	21	22⅜	23⅝	26⅜
R7	0.774	12⅜	13⅞	15½	17	18½	20⅛	21⅝	23¼	24¾	26¼	27⅞	31
R8	0.854	13⅝	15⅜	17⅛	18¾	20½	22¼	23⅞	25⅝	27⅜	29	30¾	34⅛
R9	0.918	14¾	16½	18⅜	20¼	22	23⅞	25¾	27½	29⅜	31¼	33	36¾
R10	0.974	15⅝	17½	19½	21⅜	23⅜	25⅜	27¼	29¼	31⅛	33⅛	35	39

*From INDUSTRIAL VENTILATION, American Conference of Governmental Industrial Hygienists.

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Studies conducted under direction of Heinrich Breiger, M.D., at Jefferson Medical College, Philadelphia, show that lungs accidentally exposed to highly noxious particles may be decontaminated by inhalation of inert dust.

The inert dust accelerates expulsion of biologically active particles from the lungs, when present in very small amounts.

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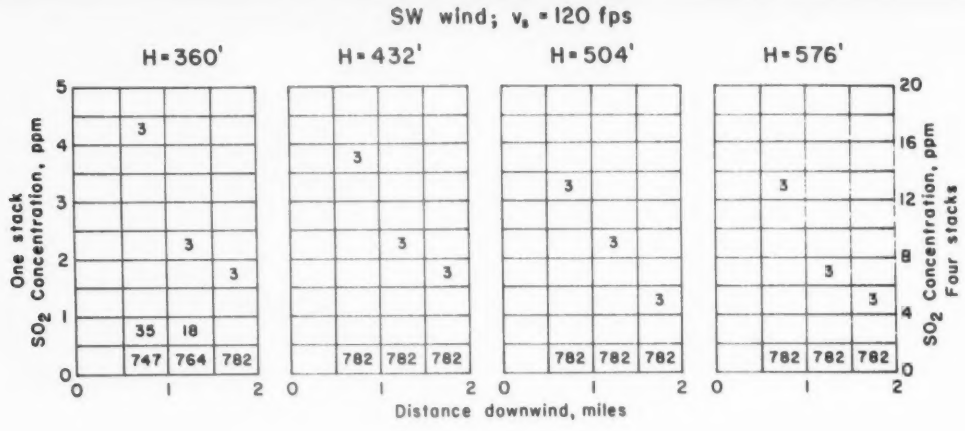

Fig. 7: *Calculated surface concentrations using diffusion equations and based on wind tunnel model tests for power plant. For each of four stack heights is shown number of hrs./yr. SO_2 concentration in ppm by vol. may lie within limits indicated, over 22½° segmental area NE of plant, for stack gas exit velocity of 120 fps (after Hewson).*

Meteorology

(Continued from page 50)

lems have a very strong meteorological component, to go along with such other elements as chemistry, sanitary engineering, health, law, and so forth.

Intensive meteorological studies have been undertaken in connection with the Los Angeles smog, the Donora disaster, the Detroit-Windsor problem, and enlightened administrators in the San Francisco Bay area have recently added a professional meteorologist to their staff. The engineer who is faced with an air pollution problem may have to deal with the meteorological aspects of his problems himself, or enlist professional assistance.

To help him in this decision we summarize the types of services the qualified meteorologist can provide. The term *qualified meteorologist* is intended to highlight the fact that the profession of meteorology has undergone tremendous specialization in recent years, and it is by no means the case that *any* professional meteorologist is qualified to offer expert guidance in matters of air pollution.

The qualified meteorologist can conduct surveys into the climatology of a site giving due weight to the mesoscale and microscale effects. As a result of such surveys he can recommend optimum locations for new plants and thus prevent a good deal of hardship and possible litigation in the future.

In other situations he can evaluate the meteorological facilities that are available, and if necessary design suitable instrumentation for continuous monitoring of those meteorological factors that are relevant to the particular problem. He may recommend and carry out special studies in situations where the interplay of the many variables is not revealed by the information that is routinely available.

Using appropriate diffusion equations and the results of model studies he may make theoretical computations of surface concentrations of the type shown in Fig. 7 to be expected from a planned power plant (9), and in this way assist in specifying the required stack heights and design capacity of collecting devices to be installed. By experience and training he is eminently qualified to assist in town planning, and he should be considered as a source of expert testimony in cases of litigation where the role of meteorology looms important. ▲▲

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Sources of Information About Qualified Meteorological Consultants

The American Meteorological Society has established a Board for Certified Consulting Meteorologists which, after exhaustive investigation and examination of the professional ethics and scientific competence of each applicant, awards a certificate to an approved candidate which entitles him to the designation "Certified Consulting Meteorologist." Among these are a number with special qualifications and lengthy experience in air pollution meteorology.

Inquiries should be directed to:

The Executive Secretary
American Meteorological Society
3 Joy Street
Boston 8, Massachusetts

How To Filter Smog

(Continued from page 26)

roof and on a 6 ft. x 8 ft. metal pan.

A note of caution: we found that the entire supply plenum must be thoroughly vacuumed with portable vacuum cleaners before starting up the system after changing filters. Removal of deactivated filters, and "lint" filters ahead of the charcoal filter bank, permitted some dust to gather in the plenum.

The charcoal filling machine accommodates filter frames up to 20 in. x 20 in. and is made of scrap sheet metal and angle iron. Compartments at top of the filler unit hold just enough carbon to fill each tube in the filter. Our only problem with this contraption is that stoppages occur in the compartment at top of the unit. Next year, when we refill carbon tubes again, we'll rig up some type of shaker that will prevent stoppages.

Our test for activated charcoal filter efficiency is simplicity itself. We fill a pint jar half full with carbon from a filter tube and drop a teaspoon of carbon tetrachloride into the jar. The jar is then capped, shaken and sniffed. If no trace of carbon tet. odor is sniffable, we know that there is 14 percent of filter life left. We then add another teaspoon full of carbon tet., cap, shake and sniff again. If there is still no trace of carbon tet. odor we know we have 28 percent activity remaining in the activated charcoal. This process is repeated until the odor is detectable, at which point we establish the percent of activity remaining in the filters.

We are very enthusiastic about the activated charcoal filter system because the smog-free atmosphere we maintain, makes building unusually attractive to tenants in this area. ▲▲

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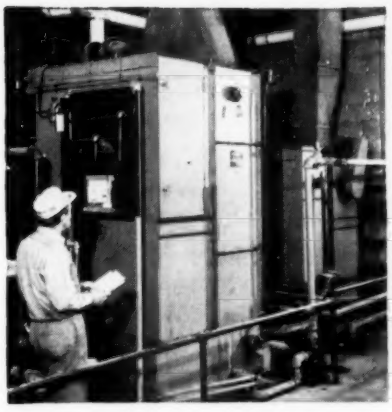

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Write for Bulletins 112 and 131 and complete information on your air conditioning problem.

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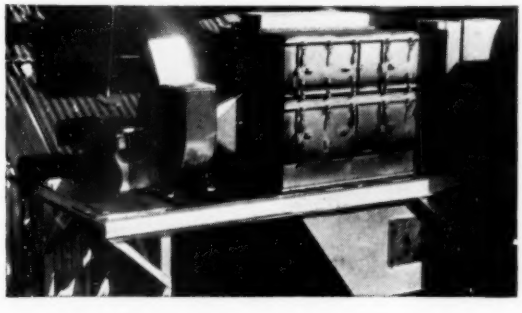

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Dustex CORP.

Factory Ventilation

(Continued from page 25)

the entire coils. Flanged fittings or unions should be provided for easy removal of valves, traps, etc., for service and repair. A by-pass arrangement should also be provided to enable removal of motorized or pneumatic actuated steam supply valves for repair without interrupting service.

A vacuum breaker arrangement should be included so the coils will drain all condensate when the steam supply valve is closed. All piping, valves, and specialties should be readily accessible. ▲▲

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Your question will be published using only your initials and state of origin, questions will be answered promptly in writing directly to you as well as published, when suitable, in the pages of AIR ENGINEERING.

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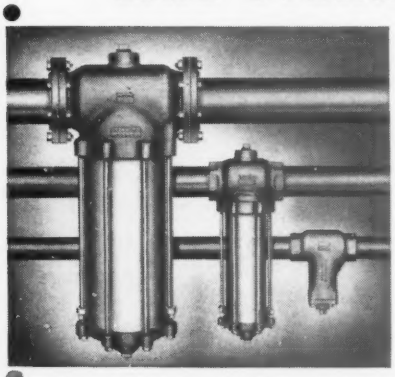

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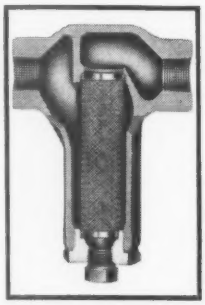

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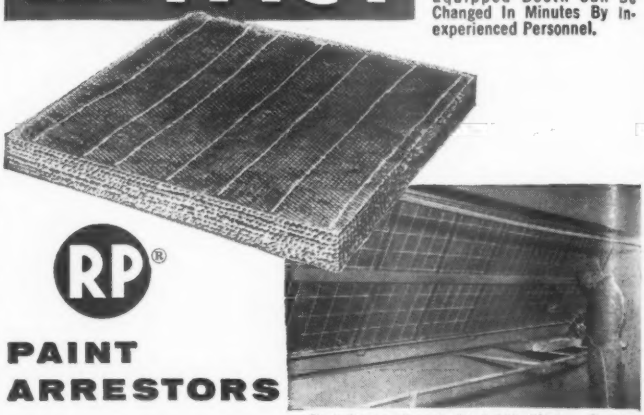

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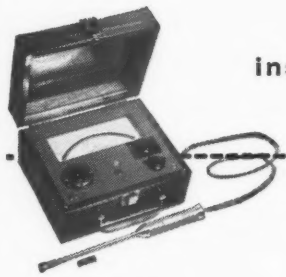

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